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Essays on the Role of Public Infrastructure and Medium-term Growth Strategies in Developing Countries (with particular Emphasis on Ethiopia)

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UNIVERSITY OF SUSSEX

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ESSAYS ON THE ROLE OF PUBLIC INFRASTRUCTURE AND MEDIUM-TERM GROWTH STRATEGIES IN DEVELOPING COUNTRIES (WITH PARTICULAR EMPHASIS TO ETHIOPIA)

SUMMARY

Ethiopia's Five–Years Growth and Transformation Plan (GTP) (2009/10-2014/15) was an ambitious economic growth strategy. The plan relied on huge investment on infrastructure, health and education to achieve a minimum average annual rate of growth of 11 percent and transform the economy from agriculture to manufacturing base. This thesis analyzes internal consistency of Ethiopia's medium-term growth strategy, and the challenges posed by the structural transformation process on monetary policymaking.

The first chapter examines the link between infrastructure capital accumulation and growth, and explores complementarities between infrastructure development and export growth strategy. To this end, a three-sector analytical model that is built from the production functions of three separate sectors, i.e., the infrastructure, exports and non-export private sectors, is developed as an analytical framework to address the gap in the literature. The estimation results indicate that public infrastructure has a strong spill-over effect on the export and non-export sectors, and differences in marginal productivities of labour and capital between export and non-export sectors range from 12.5 percent in East Asia to 250 percent in Latin America.

The second chapter explores whether the structural transformation process in developing countries affects the stability of demand for money and the effectiveness of monetary policy. The chapter applies a panel co-integration analyses on selected fast-growing African countries including Ethiopia. It is found that, given aggregate national income, a-one-percent increase in rural per-capita income, a proxy to structural transformation, boosts the demand for money by more than 0.3 percent.

In the third chapter, Ethiopia's five year Growth and Transformation plan is evaluated for internal consistency using a modified financial programming model. Given the low level of savings, the planned boost in investment on infrastructure is expected to face financing challenges. This potentially threatens the country's macroeconomic stability. The estimation results indicate that the baseline scenario is not sustainable in the long run indicating the need to reconsider current policies and strategies. Based on simulation results of six alternative policy scenarios, the exchange rate is found to be the most effective policy instruments in terms of addressing both the foreign exchange and saving-investment gaps forecasted by the baseline scenario.

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Abbreviations

BOP – Balance of Payments

FDI – Foreign Direct Investment

FPF – Financial Programming Framework

GTP – Growth and Transformation Plan

GDP – Gross Domestic Product

GMM – General Method of Moment

IMF – International Monetary Fund

LDC – Least Developed Country

LSDV – Least Square Dummy Variable

MEDAC – Ministry of Economic Development and Cooperation

MFI – Microfinance Institution

MOFEC – Ministry of Finance and Economic Cooperation

MPPL – Marginal Physical Product of Labour

MPPK – Marginal Physical Product of Capital

NBE – National Bank of Ethiopia

SDPRP – Sustainable Development and Poverty Reduction Program

TFP – Total Factor Productivity

UN – United Nations

UNCTAD – United Nations Conference on Trade and Development

USD – United States Dollar

WDI – World Development Indicator

Introduction

This thesis analyzes the current challenges of a medium-term growth strategy in developing countries and the role of public infrastructure investment with particular emphasis given to Ethiopia. The research originally stems from a personal interest on the challenges of the design of an appropriate medium-term growth strategy and a monetary policy framework in developing countries. For instance, in the late 1980s and 1990s, economists, particularly those affiliated to the World Bank advocated that developing countries, particularly Sub-Saharan Africa, should emulate the successful experiences of East Asian countries, such as South Korea and Taiwan. Hence, the structural adjustment programs implemented in the 1980s and 1990s aimed at urging African countries to reform and open up their economies, and take macroeconomic stabilization and structural policy measures that allocate resources in favour of the export sector. The Bank identified exports as the most efficient sector of the economy. However, the reform experiences of most developing countries in the wake of structural adjustment programs were disappointing. After two decades of reform experiences, most African countries found themselves poorer than they were in the 1970s.

Large disparities have been observed between the economies of East Asia, on the one hand, and economies of African and Latin American countries, on the other. In the last three decades, between 1980 and 2011, East Asian countries were growing, on average, 1.6 times and and twice as fast as Africa and Latin America, respectively. During this period, East Asian countries registered an average growth rate of 5.8 percent, compared with 3.6 percent and 2.8 percent, in Africa and Latin America, respectively. One of the main reasons for the success of East Asian economies is that they managed to attract more private investments than their African and Latin American counterparts did. For instance, the annual average private gross fixed investment to GDP ratio was 21.4 percent, which was more than twice the average registered by the

nine fast growing African countries (10.6 percent) in the panel, and more than 1.3 times the growth rate registered in Latin America (16.1 percent).

East Asian countries have also preformed far better than Africa and Latin America in terms of export growth. Therefore, they have been successfully transformed from being mainly primary commodity exporters to manufacturing goods and services exporters. Consequently, their average export-to-GDP ratio was 63 percent between 1980 and 2011, compared with 17.3 percent and 22.2 percent, in Africa and Latin America, respectively. The East Asian countries were also much more successful in terms of macroeconomic management and poverty reduction. They registered the lowest average inflation rate and the fastest reduction in poverty incidence in the last three decades, between 1975 and 2005 compared with their African and Latin American counterparts [Todaro and Smith, 2009]. These divergences in the relative performances of countries in terms of economic growth and poverty reduction have aroused interest for macroeconomists and policy makers in the developing world.

This thesis is organized in three chapters. Each chapter develops a theoretical and analytical framework to deal with three different challenges and empirically test using data drawn from secondary sources. The first challenge is to isolate the impact of infrastructure accumulation on economic growth. Even though various studies have been conducted to understand the strength of the effect of infrastructure capital accumulation on growth, the jury is still out there on the issue. The second challenge relates to understanding the effect of structural transformation on the stability of money demand function. The third challenge has to do with designing a plausible medium-term growth strategy with the right mix of policies. In the first two chapters, the thesis employs a panel data analysis on selected developing countries while the third chapter exclusively deals with the Ethiopian data. The empirical findings are used to forward policy recommendations. In the empirical analysis sections, the major challenge of the thesis was getting a continuous and sufficiently long time series data for countries in the panel, particularly for the African countries. The thesis heavily draws on data from the United Nations, IMF and World Economic Development databases for most countries. The thesis also utilizes data from the National Bank of Ethiopia, the former Ministry of Finance Economic Development (now the Ministry of Finance and Economic Cooperation) and the Central Statistics Authority reports in the Ethiopian case. The

following paragraphs briefly present the objectives and the main findings of the three chapters in the thesis.

The first chapter examines whether increasing investment on infrastructure enhances economic growth using the panel data on selected developing countries from Asia, Africa and Latin America, and tries to draw lessons to Ethiopia. In recent years, the role of infrastructure capital accumulation in enhancing economic growth has gained increased acceptance due to the increased positive outcomes from studies on the area. These studies claim that infrastructure affects long-term growth by enhancing productivities of factors input and generating positive externalities to the rest of the economies through different channels. However, there are researchers that still doubt infrastructure's growth enhancing role. The latter argues that infrastructure plays only a transitory role. It enhances growth only during the transition dynamics when the economy is moving towards the steady state equilibrium.

The chapter finds that the source of such controversies has been lack of a suitable analytical framework that allows researchers to conduct empirical test on the claims of each group. For the analysis of the role of public infrastructure on economic growth, most empirical researches rely on the conventional one-sector growth model, by adding public infrastructure capital as an additional factor input (Straub 2008a). The estimation results that come out of this model are usually controversial because the magnitude and the sign of the coefficient depend on: one, the initial stock of infrastructure capital, and two, the degree of its utilization. For instance, while researchers such as Limao and Veneables (2001), De, et al (2008), Djankov, et al (2006) who employ either micro approach or gravity models find a strong link between infrastructure capital and growth, many of the studies including Hulten and Schwab (1991), Neuser (1993), Poret (1991) and Canning and Pedroni (2004) who used a one-sector growth modelling approach found little empirical evidences on the link. Wang (2002) argues that, in countries where infrastructure investment accounts for a significant portion of the national output, empirical studies tend to find negative elasticity for real gross domestic product with respect to infrastructure capital input. Moreover, Canning and Pedroni (2004, p.19) argue, "below a growth maximizing level of infrastructure, increases in infrastructure

provision increase long run income, while above this level an increase in infrastructure reduces long run income[1]".

The main criticism on the conventional one-sector model is that it cannot capture the inter-sectoral flows of externalities in the economy. For instance, increase in infrastructure services affects aggregate output through three channels. First, infrastructure services enter the national accounts calculation as measures of final product such as electricity, water, transport and communication services. Second, public infrastructure and private factors of production have a high degree of complementarities. The provision of infrastructure services such as electric power, road network and telecom services enhances the productivity of land, labour and physical capital. This leads to higher accumulation of capital in the economy [Wang, 2002 and Straub 2008a]. Third, public infrastructure generates positive externalities to private sector output[2], as argued in the new growth theory. One of the distinguishing features of public infrastructure from private capital is that provision of its services is subject to market imperfection and, therefore, the accumulation and operation of infrastructure capital needs government intervention. As a result, the aggregate production function exhibits diminishing returns to capital and increasing returns to scale. The conventional one-sector model captures only the first channel. It cannot capture the other two channels by design as capturing the second and the third channels require splitting the aggregate production into a sector that generates externalities and a sector that benefits from the externalities.

This chapter also argues that infrastructure capital accumulation is not the only source of externalities that create market failure in developing countries. Using empirical analysis, it finds that export growth generates strong externalities to private sector production consistent with previous studies by Feder (1983), Krueger (1980) and Ram (1987). Therefore, the thesis finds that even the two sector model developed by Feder (1983) that is designed to capture inter-sectoral flow of externalities is not able to address the criticism. Therefore, I developed a three-sector model that splits the production function into three sectors: infrastructure sector, the export sector and non-

[1] Negative elsaticites coefficients imply overpovisioning of public infrastructure capital in the economy.

[2]Agenor and Montiel (1999, p.679) explain that "the presence of externalities implies that if, say, one firm doubles its inputs, the productivity of the inputs of other firms will also increase. Introducing spillover effects leads to a relaxation of the assumption of diminishing returns to capital".

export private sector. The model is tested on panel of countries drawn from Africa, East Asia and Latin America. The major findings of the model are: one, both the infrastructure and the export sectors generate positive externalities to the rest of the economy. Two, infrastructure capital accumulation and export development strategy are complementary to each other.

In the second chapter, the thesis explores whether structural transformation affects the stability of demand for money and the effectiveness of monetary policy. Available evidences indicate that rapid economic growth in many African countries since the late 1990s has resulted in rapid urbanization and increased integration of the rural people into the modern (monetized) economy. The latter affects the stability of demand for money in at least in the following two ways: first, during the structural transformation process the structure of production and trade shifts in favour of the modern sectors. Therefore, the share of national output used to be produced by family labour (in subsistence agriculture) continues to be replaced by a monetized production system. This, in turn, enhances specialization and division of labour in the rural area. Second, given rural income, increase in the availability of infrastructure services such as electricity, transport and telecommunication, raise the demand for money by the rural population. Therefore, ignoring the effect of monetization implies that, in the long run, monetary policy could potentially underestimate the extent of the demand for money, and the economy could be underprovided with long-term liquidity, which could potentially be translated into real assets.

To address this challenge, the thesis develops a demand for money model that incorporates the impact of structural transformation. Applying the model on a panel of nine fast-growing African countries including Ethiopia, the chapter finds that, given aggregate national income, a-one-percent increase in rural per-capita income, a proxy to structural transformation, boosts the demand for money by more than 0.3 percent.

The third chapter provides an empirical analysis of the medium-term growth strategy in Ethiopia using a financial programming framework. The chapter identifies two major limitations on the traditional financial programming framework. First, the model relies on the neoclassical assumption that the production function exhibits constant returns to scale with capital assumed to exhibit diminishing marginal returns [Romer, 2006, Agenor and Montiel, 1999 and Chen, 1997]. This implies that factor inputs other than

labor and capital are relatively unimportant in the production function and government policies such as investment in public goods do not have growth effects. Second, the model also relies on the extreme assumption of constant income velocity of money based on the quantity theory of money [Reinhart, 1991]. This contradicts findings of the studies that argue that in high growth countries with a rapid monetization process, the income velocity of money exhibits a continuous decline [Reinhart, 1991 pp.22-23]. Therefore, before proceeding to the empirical analysis exercise, the chapter finds it necessary to modify the exiting financial programming framework based on the theoretical and empirical analyses presented in chapter 1 and chapter 2 of the thesis.

The First Five-year Growth and Transformation (GTP I) (2011-2015) announces an annual average growth target of 11.2 percent and the vision statement indicates that the government will continue to target double digit growth in the Second and the Third Five-year Growth and Transformation Plans, to make sure that the country joins the lower middle income countries club by 2025. GTP I envisaged raising the total investment to GDP ratio from 22.3 percent in 2010 to 28.1 percent by 2013. And, the ratio is expected to grow in the Second and Third Five-year Plan periods. Given the low domestic-savings-to-GDP ratio, which was 9.5 percent in 2010, the first question that comes to mind for planers and economists is how the strategy could be sustainable in the medium term. Heavy reliance on public infrastructure investment to enhance long-term growth poses significant challenges on the sustainability of the balance of payments and the government budget. In the First Five-Year Growth and Transformation Plan, annual average foreign exchange demand to finance major manufacturing and infrastructure investment projects in the private and public sectors (excluding agriculture, services, other private manufacturing sectors and government budget)[3] is projected at Birr 315.4 billion (USD 24.5 billion) [Federal Democratic Republic of Ethiopia, 2010]. The latter is about four-fifth of the entire foreign exchange that the economy generated in the recent five years prior to the plan, i.e., 2006 to 2010.

Using the modified model, six alternative policy scenarios were run for the period 2014-2025 to see the responses of the various markets and to test how the policy shocks address the resource gaps. The model responds very positively to an exchange rate

[3]The National Bank of Ethiopia forecasted additional foreign exchange equivalent to USD 54 billion the projected amount for major sectors is needed in GTP I period to finance agriculture sector, services sectors, government budget and other non-priority public investment projects [NBE, 2011].

shock. A 40 percent one-time devaluation increases average exports to 18.4 percent of GDP during the period from 13.8 percent in the baseline. Consequently, the average annual current account deficit shrinks to USD 9.8 billion from USD 19.9 billion and the foreign exchange gap turns to a surplus for the first four years (2014-2017) of the forecast period. The saving-investment gap also sees a significant reduction, from 9.6 percent of GDP in the baseline to 6.1 percent. The second policy scenario, which aims at increasing private savings through forced savings scheme, on the other hand, seems to be less effective, although it produces the expected results in terms of the reaction of the various markets. The third scenario, which assumes a potential GDP growth rate that is 2 percentage point lower than the baseline, also produced mixed results, although the responses in terms of the narrowing of the foreign exchange and saving-investment gaps are positive. Exports see slight declines from the baseline while average inflation rises marginally to 13.2 percent from 12.9 percent in the baseline. Lower aggregate supply growth is the main reason behind the depressed export growth and rising inflation. On the other hand, the current account deficit narrows down from USD19.9 billion in the baseline to USD15.8 billion mainly due to a decline in imports.

The simulation, which runs a lower potential growth assumption combined with a 20 percent devaluation of the Birr, gets positive responses in almost all markets considered except in the money market. Notwithstanding a 2-percentage points reduction in potential GDP growth, the 20 percent devaluation boosts exports to 15.2 percent of GDP from 13.4 percent in the baseline. Consequently, the average annual current account deficit goes down to USD 11.1 billion from USD19.9 billion. The saving-investment gap experiences a significant improvement, narrowing to 3 percent of GDP. Therefore, the lesson drawn from this exercise is that use of combined policies produces better results than taking one policy measure at a time. The contractionary monetary policy scenario that aims at addressing the money market disequilibrium by reducing the base money, also produced the expected results. Inflation goes down, resulting in a real deprecation of the exchange rate.

Last but not the least is the lesson from the sixth scenario, which solves for the equilibrium exchange rate. The simulation that targets a zero foreign exchange gap throughout the projection period has demonstrated that exchange rate is an effective policy instrument in addressing the resource gap problem. It illustrates that exchange

rate adjustment does not need to be a one-time big shock, but instead must be a carefully designed series of depreciations that takes into account the projected resource gaps in individual years. One issue with this policy conclusion is to ask whether a steady and anticipated depreciation will have the same effects as the essentially unforeseen surprise devaluation that the financial programming model presumes.

To conclude, the analysis of this chapter shows that the targets in the Growth and Transformation Plans could be achieved only if the inconsistencies observed in the baseline scenario between the targets and the policy mixes and, the consequent widening resources gaps are properly addressed. This demands the government to re-examine its current policy mixes.

Chapter 1

Public infrastructure, Exports and Growth: The Experiences of Selected African, Latin American and East Asian Countries

1.1 Introduction

This chapter provides an analytical framework to empirically examine the link between public infrastructure capital accumulation and economic growth. Using a growth accounting framework, a three-sector model is developed in an endogenous growth framework that allows capturing spillover effects from infrastructure to the export and non-export private sectors[4] and from the export to non-export private sector. Moreover, the model helps to empirically address the puzzle that 'why opening up of economies to international markets were successful in some countries, particularly in East Asian countries, in terms of enhancing economic growth, and not in others' [Todaro and Smith, 2009]. Moreover, the chapter tries to draw policy lessons to Ethiopia's Five-year Growth and Transformation Plan (GTP), which gives heavy emphasis on big pubic infrastructure projects.

[4] Other non-export sector includes non-export private and non-export-non-infrastructure public sectors.

The link between infrastructure and economic growth has been a subject of considerable interest to development economists in recent years. Since the seminal paper by Aschauer (1989), a large number of studies have been published on the area, some for and some against the infrastructure-growth nexus hypothesis.[5] In recent years, literature seems to converge to the idea that infrastructure indeed has a significant growth enhancing effect [Agenor, et al 2005; Caldaron and Serven, 2003; Liamo and Venables, 2001; and Esfahani and Ramirez, 2003]. This view has, however, been contested by Neuser (1993), Poret (1991) and Canning and Pedroni (2004), which claim that recent studies have overstated the contribution of infrastructure to long-term growth[6]. For instance, Canning and Pedroni (2004) use an error-correction model to estimate the bidirectional causation effects. They find no effect of infrastructure on long-term growth on average, although they do find that it is not universally true for all countries and that in some there is evidence of overprovision while in others there is evidence of under-provision.

Currently, there is a general consensus that infrastructure capital accumulation enhances long-term growth. The recent debate seems to focus on whether it is quantity or quality of infrastructure that matters most in developing countries. The poor quality of infrastructure capital could arise due to either over-provisioning of infrastructure capital or underfunding of operations and maintenance expenditures [Wang, 2002; Calderon and Serven, 2008; and Adam and Bevan, 2015]. Focus on investment in new infrastructure capital, without paying proper attention to the quality of its services, 'has a powerful macroeconomic consequence, in particular for the sustainability of growth' [Adam and Bevan, 2015][7]. Moreover, a study by Calderon and Serven (2008, p. 29) finds a "robust evidence that infrastructure development – as measured by an increased volume of infrastructure stocks and an improved quality of infrastructure services – has a positive impact on long-run growth and a negative impact on income inequality".

[5]For instance, studies by Aschauer (1989), Calderon and Serven (2004), Agenor et al (2004) and Calderon (2009) argue that infrastructure accelerates growth. On the other hand, Hulten and Schwab (1991), Hulten (1996), Holtz_Eakin and Schwartz (1995), Rodriguez (2006) and Straub et al (2008) tend to argue that infrastructure has only a transitory effect on growth.

[6] These studies argue that infrastructure capital accumulation relaxes growth constraints and increases the level of output by expanding the economy's capacity to absorb more private capital. For instance, in electric power constrained economies, improving the capacity of electric power generation allows more new private investment and also full capacity utilization of existing firms. However, long term growth remains unaffected.

[7] Adam and Bevan (2015, p.ii16) argue, "what matters for growth is the sustained flow of productive services provided by the public capital stock to private factors of production, which in turn requires that the capital stock is efficiently operated and maintained".

This chapter also argues that infrastructure capital accumulation is not the only source of externalities that create market failure in developing countries. Using empirical analysis, it finds that export growth generates strong externalities to private sector production consistent with previous studies by Feder (1983), Kruger (1980) and Ram (1987). Concerning the contribution of exports, Kruger (1980, p.401) asserts that, "time-series and cross-section data have been pooled, so that deviations of countries' growth from their trends have been estimated as a function of the growth of export earnings. In all of these specifications, the rate of growth of exports has turned out to be a highly significant variable". In the late 1980s and1990s, economists, particularly those from the World Bank, advocated to developing countries, particularly to Sub-Saharan Africa, to emulate the successful experiences of East Asian countries, such as South Korea and Taiwan. So, the structural adjustment programs implemented in the 1980s and 1990s were urging the reforming African countries to open up their economies and take macroeconomic stabilization and structural policy measures that allocate resources in favour of the export sector, which is identified as the most efficient sector. The reform experiences of most of developing countries in the wake of structural adjustment programs were not, however, encouraging.

A number of studies tend to argue that, in the 1980s and 1990s, the main explanation for the growing divergence between East Asian countries, on the one hand, and African and Latin American countries, on the other, was the gap in the state of social and physical infrastructure. While East Asian countries undertook extensive infrastructure development programmes[8], investment in infrastructure declined significantly in most African and Latin American countries (see the discussions in Todaro and Smith, 2009; Cudmore and Whalley's, 2002 and Straub, 2008a). For instance, Straub (2008a, p.33) indicates, "While in recent years major Latin American countries have invested less than 3% of GDP on average [quoted from Fay and Morrison, 2007], some East Asian countries like China and Vietnam are investing around 10% of their GDP in infrastructure [quoted from Straub, Vellutini and Walters, 2008]".

Despite the general consensus in the literature that public infrastructure capital accumulation has a growth enhancing effect, there is a gap in the available analytical

[8] For instance, Todaro and Smith (2009) states that, 'Taiwan inherited an infrastructure system far superior to that of most poor countries from the period of Japanese colonial rule (1905-1945). And, the Taiwanese government supplemented this by undertaking extensive infrastructure development program in the 1950 and 1960s'.

macro frameworks to test the conjecture. Particularly, the existing analytical frameworks are not capable of incorporating externalities generated from more than one sector[9]. Therefore, this chapter tries to fill this gap by providing theoretical and analytical frameworks that explain the presence of complementarities between the three sectors - the infrastructure, the export and the private domestic output sectors.

The remaining part of the chapter is organized as follows: section 1.2 presents the theoretical framework for the three-sector model. Section 1.3 analyzes limitations of the existing analytical frameworks. The structure and theoretical foundation of the three-sector model is presented in section 1.4. Section 1.5 and section 1.6 describe data sources and methodology of estimation, respectively, while section 1.7 presents the estimation results. Finally, the chapter concludes by giving summary and policy implications in section 1.8.

1.2 Theoretical Framework

1.2.1 Infrastructure-Economic Growth Nexus

Recently, growth literature on developing countries has shown considerable interest in analyzing the role of public infrastructure capital accumulation on economic growth. A number of studies argue that investment in public infrastructure boosts private sector productivity, and entice the private sector to accumulate more capital.

Wang (2002) categorizes the effects of infrastructure on aggregate output into three. First, infrastructure services enter the national accounts calculation as measures of final product such as electricity, water, transport and communication services. Second, public infrastructure and private factors of production have a high degree of complementarities. The provision of infrastructure services such as electric power, road network and telecom services enhances the productivity of land, labour and physical capital. Agenor (2005, p.6) argues that "by raising the marginal productivity of private inputs (both labour and capital), public infrastructure raises the perceived rate of return

[9] The existing theoretical and analytical frameworks fail to recognize the inter-sector spillover effects, particularly the presence of complementarities between the infrastructure and the export sectors. As a result, it becomes difficult for policy makers to design policies that enhance the inter-sector spillover effects and give particular focus on the sector that produces optimal results.

on, and increases the demand for, physical capital by the private sector". This leads to higher accumulation of capital in the economy [Wang, 2002 and Straub 2008a].

The third channel is the positive externalities that public infrastructure generates to private sector output[10], as argued in the new growth theory. As a result, the aggregate production function exhibits diminishing returns to capital and increasing returns to scale [Agenor and Montiel, 1999 and Acemelugu, 2009]. Growth literature treats infrastructure as a public good, which has general characteristics of being non-rival and non-excludable [Agenor, 2005]. One of the distinguishing features of public infrastructure from private capital is that provision of its services is subject to market imperfection and, therefore, the accumulation and operation of infrastructure capital needs government intervention. Ramirez and Esfahani (1999, p.5) argue, "Infrastructure services often entail economies of scale due to network externalities. And, cost recovery from users tends to be more difficult and inefficient because often the marginal cost is declining, the services are viewed as basic needs (e.g. water), or exclusion of non-paying users is too costly (e.g. urban streets and rural roads)."

In a purely competitive economy, the presence of such externalities leads to an underinvestment in infrastructure capital because private agents do not take into account the external benefits of infrastructure capital accumulation. Therefore, for the equilibrium growth rate to be close to optimal, government needs to invest in infrastructure capital, and, thereby, reduce the production costs of the economy, particularly the private sector[11] [Agenor and Montiel, 1999]. A study by Albala-Bertrand and Mamatzakis (2004) on the Chilean economy finds that an increased infrastructure capital reduces the production cost of the economy, thereby increasing productivity. Moreover, Easterly and Servén (2003) argue that the growing divergence between East Asia and Latin America could be attributed to the growing gap in infrastructure investment between the two regions. They found that public infrastructure investment declined significantly in a number of Latin American countries in the 1980s and 1990s due to fiscal adjustments.

[10] Agenor and Montiel (199, p.679) explain that "the presence of externalities implies that if, say, one firm doubles its inputs, the productivity of the inputs of other firms will also increase. Introducing spillover effects leads to a relaxation of the assumption of diminishing returns to capital".

[11] As an intermediate input public infrastructure services enters into the private sector production and enhances the productivity of all other inputs [Agenor, 2005 and Caldaron and Serven, 2003]. For instance, an expansion in road networks reduces commuting time thereby enhancing labour productivity indirectly; reduces the cost of transporting goods to and from ports or other towns, and improves private capital durability [Straub, 2008a].

1.2.2 Exports-Economic Growth nexus

In the late 1970s and 1980s, even before the advent of the new growth theory and infrastructure-growth nexus starts to gain wider acceptance in the literature, export growth and out-ward oriented economic policies began to arouse the interests of economists, particularly the World Bank, following the success stories of East Asian countries such as South Korea and Taiwan, and the failures of import substitution strategies in most Latin American and African countries [Clarcq, et al, 2006; Rodríguez, 2006; Bruton, 1998; Krueger, 1980; Chenery, 1986; and Feder, 1983; and Todaro and Smith, 2009]. The central arguments in favour of export-growth linkage are: first, there are differences in the marginal productivities of factor inputs between the export and non-export sectors. Countries that follow policies that favour exports tend to have closer-to-optimal resource allocation and higher rates of growth of national income. Competitive pressures in the international market make them spend a significant portion of their resources on innovation and R&D: Caldera (2009), using panel data analysis on Spanish manufacturing industry, found that after controlling for size, temporal and industry differences, exporters appear to spend more in innovation (20 percent) than non-exporters, and introduce more product innovations (13 percent) and process innovations (7 percent).

Secondly, apart from factor allocation effect, exports also generate externalities to the rest of the economy by facilitating "development of efficient and internationally competitive management, the introduction of improved production technique, training of higher quality labour, steadier flow of improved inputs, etc" [Feder, 1983 p.61]. Clercq, et al (2006, p.40), using unbalanced dataset for 34 countries for the period from 2002 to 2005, found that "entrepreneurs' export orientation functions as a catalyst for the emergence of new businesses within a country's borders, and that such export orientation by itself is influenced by a country's levels of outward foreign direct investment (FDI), export and import". In fact, in developing countries, the externalities would be more through technology adaption and reverse-engineering than through invention of new ideas [Grossman and Helpman, 1991].

Thirdly, countries with export-oriented economic strategies contribute to economic growth by offering greater economies of scale due to enlargement of the effective size of the market (Ram, 1987). This in turn widens market opportunities to non-export

sectors and allows them to enjoy all other benefits of economies of scale such as improved managerial skill, specialization and division of labour [Feder, 1983].

Fourthly, export oriented policies increase the rate of growth of domestic savings[12] by increasing corporate savings and encouraging governments of developing countries to adopt prudent macro-economic policies that boost personal savings. A sustainable increase in the rate of growth of exports implies a continuous improvement in the country's competitiveness in the international market (thereby, profit margins of firms increase). Second, retaining a competitive position in the international market entails government commitment to maintain macro-economic stability through prudent monetary and fiscal policies. For instance, Krueger (1980 p.403) argues, "... an export-oriented strategy imposes constraints on policy makers. Policy makers receive feedback in a relatively short time period as to the cost of their policies". There is now a general consensus that the most important reason for the East Asian economies success is the adoption of an export oriented industrial strategy [Chen, 1997; Todaro and Smith, 2009; and Feder, 1983]

1.2.3 Infrastructure-Export Performance-Growth Nexus

In growth literature, the link between infrastructure capital accumulation and export growth is less controversial than the link between infrastructure and growth or exports and growth [De, Khan and Chaturvedi, 2008; Fedderke and Bogetic, 2006; and Limao and Venables, 2001]. But, what has not been explicitly dealt with in the literature is the presence of complementarities between infrastructure capital accumulation and export growth and their role in realizing optimal long-term growth. The complementarities between infrastructure capital and export growth strategy arise from the necessity to exploit the opportunities of economies of scale and scope. Infrastructure, as has been described in section 1.2.1 above, increases the productivity of factor inputs and generates additional externalities to private firms through improved transport and communication network, lower transport and financial transaction costs and creating

---

Domestic savings is a reflection of the performance of the current account balance of the BOPs: X-M = (S-I) + (T-G). The identity is derived from the domestic aggregate demand and aggregate supply relationships: C+I+G+X-M = C+S+T, where

X is exports of goods and services, M is imports of goods and services; S is private savings; I is private investment; T is government total tax revenue; G is government total expenditure; Yd is aggregate demand; and Ys is aggregate supply.

greater economies of scale for private firms [Straub, 2008a]. In developing countries, with a narrow domestic market, the benefits of infrastructure capital could not be fully utilized and translated to long-term growth benefit if the countries are not ready to take advantage of the wider market opportunities available outside their borders.

A number of studies confirm that investments in transport, ports, electricity and/or telecommunication reduce trade and transaction costs thereby enhancing a (developing) country's participation in international trade and accelerating regional integration efforts [De, Khan and Chaturvedi, 2008; Djankov, Freund and Pham, 2006; Fedderke and Bogetic, 2006; and Limao and Venables, 2001]. For instance, Limao and Venables (2001), using a cross-section model, found that a 10-percentage-point increase in transport costs typically reduces trade volume by approximately 20 percent.

In fact, as a strategy, improvements in transport, telecommunication and/or port infrastructure are more effective in terms of making the country open to international trade than the traditional trade liberalization measures such as tariff and non-tariff barrier reduction and exchange rate adjustments in developing countries [De, 2007; Das and Pohit, 2006; Cudmore and Whalley, 2002; and Djankov, Freund and Pham, 2006]. The study by Cudmore and Whalley's (2002) has found that trade liberalization, before relaxing major trade-related infrastructure constraints, such as transport and ports infrastructure, is welfare worsening[13]. These findings imply that in developing countries where transport and logistics costs make up a significant portion of production costs, an export growth strategy, without an adequate strategy to address deficiencies in domestic infrastructure services, could not make exports successfully competitive in the world market. Citing World Bank (2001), De (2007, p.3), discusses that for "the majority of Sub-Saharan African countries, Latin American and Caribbean, and a large part of Asia, transport cost incidence for exports is five times higher than tariff cost incidences"[14]. Moreover, Limao and Venables (2001) estimate that intra-Africa transport costs are 136 percent higher than predicted by a standard gravitational model, and 59 percent of these costs is attributed to poor infrastructure.

[13]This goes with Rodrik's (2006) argument that reforming countries have to undertake serious diagnostic measures, and prioritize the reform areas. Referring to the East Asian Development experience, hesuggests that developing countries need to identify the most binding constraints and work with that first.

[14] De (2007, p.24) found that a 10 percent saving in transport costs is likely to increase trade by about 6 percent.

Rodriguez (2006) also finds that despite market-oriented reforms during the 1980s and 1990s, disparities between the incomes of poor and rich countries continue to widen. Using empirical evidence, he asserts that decline in infrastructure investment that has occurred in many developing countries in the 1980s and 1990s was one of the major explanations for this great divergence in world incomes. All these imply that there are strong complementarities between infrastructure and export growth. Therefore, an export growth strategy, without infrastructure development policies or vice versa, would produce sub-optimal results, and is expected to be less successful in enhancing long-term growth.

1.3 Limitations of Existing Analytical Frameworks

1.3.1 A One-Sector Growth Regression Model

Most macro literature employ a one-sector production function similar to equation (1.1) as a framework to analyse the contribution of infrastructure to growth [Straub, 2008a; Straub, et al 2008b; Esfahani and Ramirez, 1999; Button, 1998; Canning and Pedroni, 2004].

$$Y = AG^{\alpha} L^{\beta} K^{1-\alpha-\beta} \quad \text{..... 1.1}$$

where Y is real aggregate output, K is the (non-infrastructure) aggregate capital stock, L the labour force, G the infrastructure capital stock, and A is a parameter that captures factors affecting the level of technology or what is called exogenous technical progress; and $\alpha, \beta \in (0, 1)$. Thus, the production function exhibits constant returns to scale in all factors [Agenor and Montiel, 1999].

Multiplying equation (1.1) by K/K and collecting similar terms together, we get the following equation [Agenor and Montiel, 1999].

$$Y = A(G/K)^{\alpha} (L/K)^{\beta} K \quad \text{..... 1.2}$$

At the steady-state, (G/K) and (L/K) are constant. Therefore, output exhibits linearity in the stock of private capital and, therefore, the production function exhibits constant returns to scale in all factors of inputs – including G [Agenor and Montiel, 1999]. In

equation (1.2), all factor inputs are viewed as some form of reproducible capital (human and physical capital) with an AK-type technology. In this framework, infrastructure has labour and capital augmenting effect.

The above framework is subject to the following two limitations: One, the model captures only the direct (factor productivity effects) of infrastructure capital accumulation. Capturing the indirect (externalities) effect requires making total factor productivity (or the technical progress term A) as a function of externalities such as road and power network, use of improved technology, and economies of scale, among others. However, these externalities are difficult to incorporate in a one-sector production function framework because capturing externalities requires splitting the production functions between the sector that generates externalities and the sector that benefits (from the former). This is because outputs of the sector that generates externalities would be used as additional factor inputs in production function of the sector which benefits from the externalities[15] [Wang, 2002; Feder, 1983 and Agenor and Montiel, 1999].

Two, inherent in the one-sector production function is the assumption that factor (labour and capital) productivities are equal across sectors in the economy. So, the framework does not accommodate factor reallocation externalities between sectors. A number of studies argue that factor reallocation to the most productive sectors could be an important source of growth in least developed countries.

1.3.2 The Growth Accounting Equation

Taking total derivative of equation (1.1), we can derive the following growth accounting equation:

$$dY/Y = \alpha*dG/G + \beta*dL/L + (1-\alpha-\beta)*dK/K \quad \text{..... 1.3}$$

Then, by adding a constant and an error term, we can use equation (1.3) for empirical analysis as follows:

$$dY_t/Y_t = \alpha_0 + \alpha_1*dG_t/G_t + \alpha_2*dL_t/L_t + \alpha_3 dK_t/K_t + u_t \quad \text{..... 1.4}$$

[15]When both the direct and indirect effects of infrastructure capital are captured, the production function exhibits increasing returns to scale, instead of constant returns to scale [Agenor and Montiel, 1999].

α_1 is the elasticity of output with respect to public infrastructure, α_2 is the elasticity of output with respect to labour and α_3 is the elasticity of output with respect to private capital. The elasiticities are estimated using data on the shares of income that go to the respective factor inputs. From equation (1.4), we can derive the Solow residual (R_t) as follows:

$$R_t = dY_t/Y_t - (\alpha_0 + \alpha_1 * dG_t/G_t + \alpha_2 * dL_t/L_t + \alpha_3 dK_t/K_t) \quad \text{..... 1.5}$$

In equation (1.5), R measures anything but the private returns of factor inputs, i.e., G, L and K, such as economies of scale, export growth, human capital development, and other factors that affect technological changes [Chenery, 1986; Romer, 2006; Feder, 1983; and Agenor and Montiel, 1999]. The large unexplained residuals[16] in growth accounting, and the empirical challenge that countries actually grow at a speed higher than that could potentially be predicted by the neo-classical model for a longer period, and growing divergence of growth between countries[17] have been mentioned as evidences of the presence of externalities that could not be explained by a change in the quality or quantity of factors of production[18] [Agenor and Montiel, 1999].

Quite a number of studies apply a growth accounting technique to know the proximate determinants of growth, particularly the contributions of factor inputs such as labour, capital and other inputs over some period, without going deeper into the analysis of what causes the changes in the determinants themselves[19] [Romer, 2006; Arslanalp et

[16]Harberger (1989, p. 94) explains that "the residual was initially thought of as a coefficient of technical advance (since it effectively measured the growth of output per unit of input), but it was quickly recognized to be a composite of the effects of many different foreces: (i) improvements in the quality of labour through education, experience, and on the job training; (ii) reallocation of resources from low-productivity to high-productivity uses, either through normal market forces, or through the reduction of barriers or distortions; (iii) expoitation of economies of scale; and (iv) improved ways of combining resources to produce goods and services, not just at the level of new machines or processes, but also by relatively mundane adjustments at the level of the factory or the farm.".

[17]Agenor and Montiel (1999, p. 669) states that "in 1960 average real per capita incomes in Asian and African countries were roughly similar. Thirty years later, income per capita had more than tripled in Asia while it had risen only moderately in Africa".

[18]Straub (2008b, pp 4-5) describes that "An important feature of East Asia's infrastructure history has been the construction of major transport links between cities. Korea's Seoul-Pusan highway built in the 1960s, Malaysia's road network built in the 1970s and 1980s, China's rail network and more recent express ways development, and Vietnam's Hanoi-Ho Chi Minh city and Hanoi-Haiphery have all enlarged and integrated domestic markets, as well as providing the logistical connections for access to port and international markets. Further investment in these transport networks may not give the same boost to productivity, but it is possible that the larger markets they facilitate the exploitation of economies of scale within firms, the production of more specialized skills match between employers and workers."

[19] The growth accounting framework has been widely applied in individual country growth analysis and cross-country growth comparisons [Arslanalp et al, 2010; and Straub et al, 2008; Young, 1995; Feder, 1983; Ram, 1987; Agenor and Montiel, 1999; Wang and Yao, 2003; and Wang, 2002].

al, 2010; and Straub et al, 2008]. Romer (2006) argues that growth accounting does not get at the underlying sources of growth. It only examines its immediate determinants. He argues that assuming an economy on its balanced path described in the Solow growth model, it is known that, in this case, growth is coming entirely from growth in A. However, growth accounting attributes only a fraction to the residual (R). The other fractions are attributed to growth in factor inputs[20].

1.4 Structure and Theoretical Foundation of the Three-sector Model

This section presents the structure and theoretical foundations of the three-sector model that is believed to address the shortcomings of existing macro approach growth accounting models. The model is developed following Feder (1983) and Wang (2002) two-sector production function approaches. The main assumptions of the model are: First, infrastructure and export sectors have spill-over effects. While infrastructure generates externalities to exports and non-export sectors through productivity and capital accumulation effects, exports generate externalities to the non-export private sector through productivity and capital accumulation. Two, there are productivity differences between the export sector and non-export sectors. As a result, factor allocation in favour of the export sector improves factor productivity and enhances economic growth. Third, due to positive externalities from infrastructure and export sectors, aggregate output exhibits increasing returns to scale.

Basic structure of the model is as follows:

$$\begin{cases} F = F(L_F, K_F, G_F) \\ X = X(L_X, K_X ; F) \\ R = R(L_R, K_{R,}; F, X) \\ Y = F + R + X \end{cases} \quad \text{..... 1.6}$$

where, Y is total output (GDP) at factor cost; F is infrastructure service outputs; R is non-export private sector output; X is exports of goods and services; K_F and L_F are private capital stock and labour inputs in public infrastructure sector respectively; K_R

[20] Hence, Barro (1998, p.1) argues that the growth accounting technique could be particularly useful if the fundamental determinants of that matter for factor growth are substantially independent from those that matter for technological change.

and L_R are private capital stock and labour inputs in non-export private sector respectively; K_X and L_X are private capital stock and labour inputs in export sector respectively, L is labour and G_F is infrastructure capital stock. All variables are in constant prices.

As a factor input, G enters the infrastructure sector production function, F(.), to produce infrastructure services. Private capital stock (K_F) also enters in F(.) because the sector is assumed to hire some of the services of private capital such as machineries, buildings and equipments [Feder, 1983; Ram, 1987; and Wang, 2002].

Infrastructure capital accumulation contributes to real GDP in three ways: one, infrastructure services are counted as final outputs such as electricity, transport and communication. Two, as intermediate input, infrastructure capital accumulation enhances productivities of all other factor inputs, and, as a result, boosts capital accumulation. This is the complementarities argument. Three, infrastructure output (F) enters both in non-export private sector output and exports production function because it generates positive externalities to these sectors.,

In the export production function, F is expected to raise factor productivity in the sector, and generates positive externalities by providing network externalities, lowering transaction costs such as transport and logistics costs and creating economies of scale. By definition, R includes both non-tradable and import substituting tradable goods. Hence, improvements in infrastructure services and reduction in transport costs benefit both imports and domestically produced goods. However, positive externalities to import substituting domestic outputs is expected to outweigh that of direct imports for the following two reasons: one, through the direct and indirect effect of infrastructure capital accumulation, domestic industries benefit not only from the reduction in transaction costs (such as transport costs) but also the increase in productivities of factor inputs and technical progress. Two, market imperfections through tariffs and taste-biases towards home-produced traded goods tend to boost the demand for domestic products even for those products with prices (including tariff) close to that in the international market [Benigno and Thoenisson, 2003].

On the other hand, exports enter, as a factor input, in the non-export private sector production function. It is assumed that export growth enhances private sector output through two channels: one, it generates externalities to the sector by creating economies

of scale to domestic firms, providing internationally competitive managerial skill, trained labour and use of improved technology. Two, it is also assumed that marginal factor productivities of factor inputs in the export sector are higher than that of the non-export sectors. Hence, reallocation of factor inputs from non-export sector to the export sector enhances growth.

Following Feder (1983), the marginal productivity differences are formulated as follows:

$$\begin{cases} \underline{MPPL_F}/MPPL_R = \underline{MPPK_F}/MPPK_R = 1, \\ \underline{MPPL_X}/MPPL_R = \underline{MPPK_X}/MPPK_R = 1 + \delta \end{cases} \quad \text{..... 1.7}$$

$$-\infty < \delta < \infty$$

where $MPPL_F$, $MPPL_X$ and $MPPL_R$ represent marginal physical product of labour in the infrastructure, export and non-export private sector respectively, and $MPPK_F$, $MPPK_X$ and $MPPK_R$ are marginal physical product of capital in the infrastructure, export and non-export private sectors, respectively.

Equation (1.7) indicates that marginal productivities of factor inputs in the export sector are higher by a factor equal to 'δ' than those in the rest of the economy. Feder (1983) presents three reasons for the differences. One, exporting firms operate in a more competitive environment than the rest of the economy. So, they tend to have more skilled labour, and internationally competitive and efficient management. Moreover, exporting firms also tend to invest on research and development. Two, exports are less regulated and face fewer constraints such as credit and foreign exchange shortages in developing countries. Three, export firms operate in high perceived uncertainty.

Taking total differentials of individual equations in equation (1.6) yields

$$\begin{cases} dF = \partial F/\partial K_F\,(dK_F) + \partial F/\partial L_F\,(dL_F) + \partial F/\partial G_F\,(dG_F) \\ dX = \partial X/\partial K_X\,(dK_X) + \partial X/\partial L_X\,(dL_X) + \partial X/\partial F\,(dF) \\ dR = \partial R/\partial K_R\,(dK_R) + \partial R/\partial L_R\,(dL_R) + \partial R/\partial F\,(dF) + \partial R/\partial X\,(dX) \end{cases} \quad \text{……...…..... 1.8}$$

Then using the relationship in equation (1.7) and substituting $(1+\delta)\ \partial R/\partial K_R$ for $\partial X/\partial K_X$ and $\partial R/\partial K_R$ for $\partial F/\partial K_F$; and doing similar substitutions for labour inputs in equation (1.8) yields:

$$\begin{cases} dF = \partial R/\partial K_R\,(dK_F) + \partial R/\partial L_R\,(dL_F) + \partial F/\partial G_F\,(dG_F) \\ dX = (1+\delta)\,\partial R/\partial K_R\,(dK_X) + (1+\delta)\,\partial R/\partial L_R\,(dL_X) + \partial X/\partial F\,(dF) \\ dR = \partial R/\partial K_R\,(dK_R) + \partial R/\partial L_R\,(dL_R) + \partial R/\partial F\,(dF) + \partial R/\partial X\,(dX) \end{cases} \quad \text{..... 1.9}$$

Following Feder (1983), I assume a linear relationship exists between the real marginal productivity of labour in a given sector and average output per labour in the economy. This was originally argued by Bruno (1968).

$$\partial R/\partial L_R = B(Y/L) \quad \text{..... 1.10}$$

Let $\partial R/\partial K_R = \alpha$; $\partial F/\partial G = \mu$; $\partial R/\partial X = c$; where α, μ and c are constants representing marginal changes in the respective sectors with respect to a change in private capital, pubic capital and export output.

Using the national output relationship in equation (1.6), i.e., Y= F+R+X; dividing all equations in 1.9 by Y; and replacing $\partial R/\partial L_R$ by B(Y/L), we get

$$dY/Y = \alpha(dK/Y) + \beta(dL/L) + \mu(dG_F/Y) + [1/(1+\delta)]\partial X/\partial F(dF/Y) + \partial R/\partial F(dF/Y) + \partial R/\partial X(dX/Y) + \delta/(1+\delta)dX/Y \quad \text{..... 1.11}$$

A plausible specification for the spillover effects is to assume that public infrastructure affects export and non-export private sectors with a constant elasticity and, similarly, export affects the non-export private sector with a constant elasticity. The constant elasticity indicates the long-run partial effects of infrastructure output and export growth on the respective sectors [Wang, 2002]. So, we can reformulate the production functions in euqation (1.6) as follows:

$$R = R(L_R, K_{R,}; F, X) = (F)^{Z}\psi\,(L_R, K_{R,}; X) \quad \text{..... 1.12}$$

$$R = R(L_R, K_{R,}; F, X) = (X)^{\omega}\Psi(L_R, K_{R,}; F) \quad \text{..... 1.13}$$

$$X = X(L_X, K_X; F) = (F)^{V}\phi\,(L_X, K_X) \quad \text{..... 1.14}$$

Therefore,

$$\partial R/\partial F = z(R/F) \quad \text{..... 1.15}$$

$$\partial X/\partial F = v(X/F) \quad \text{..... 1.16}$$

$$\partial R/\partial X = \omega(R/X) \quad \text{..... 1.17}$$

Substituting equations (1.15), (1.16) and (1.17) into equation (1.11), we get equation (1.18) below (for detailed derivation and assumptions of the model see Annex 2.1)

$$dY/Y = \alpha(dK/Y) + \beta(dL/L) + \mu(dG_F/Y) + [1/(1+\delta)]\, v(X/F)(dF/Y) + z(R/F)(dF/Y) + \omega(R/X)(dX/Y) + \delta/(1+\delta)dX/Y \quad \text{1.18}$$

Rearranging terms in equation (1.18),

$$dY/Y = \alpha(dK/Y) + \beta(dL/L) + \mu(dG_F/Y) + [v/(1+\delta)]\,(X/Y)(dF/F) + z(R/Y)(dF/F) + \omega(R/Y)(dX/X) + \delta/(1+\delta)(dX/X)(X/Y \quad \text{1.19}$$

Alternatively, following Wang (2002), one can also assume that, not only current infrastructure output, but also expected growth in infrastructural output attracts more private investment. He argues that private firms tend to be attracted to an economy where there is a strong commitment to improved infrastructure services. The higher the rate of growth of infrastructure output is, the larger would be the volume of private investment.

Therefore, replacing F by F*, equation 1.19 could be expressed as:

$$dY/Y = \alpha(dK/Y) + \beta(dL/L) + \mu(dG_F/Y) + [v/(1+\delta)]\,(X/Y)(dF^*/F^*) + z(R/Y)(dF^*/F^*) + \omega(R/Y)(dX/X) + \delta/(1+\delta)(dX/X)(X/Y) \quad \text{1.20}$$

Equation (1.20) implies that expected infrastructure output growth has a capital accumulation effect. Wang formulated the following equation for expected infrastructure output.

$$F^*_t - F^*_{t-1} = \theta\,[F_{t-1} - F^*_{t-1}], \qquad 0 < \theta \leq 1 \quad \text{1.21}$$

Equation (1.21) follows lagged adjustment mechanism where F* is the expected rate of infrastructure output and θ is adjustment parameter. After recursive expansion, the dynamic adjustment process of equation (1.21) could be re-expressed as:

$$F^*_t = \theta\textstyle\sum_s (1-\theta)^s F_{t-s}\,; \qquad 0 < s < \infty \quad \text{1.22}$$

Wang (2002, p.419) explains that "... the expected level of F, which factors in the externality onto the private sector, is a weighted average of all present and previous values of F_t, since the weight sums to unity $[\theta\sum(1-\theta)^s = 1]$".

Substituting equation (1.22) into equation (1.20) produces a specification associated with the adaptive expectation process. Equation (1.23) below is identical to the formulation of the the geometric distributed lag [Wang, 2002; Allen 1967; and Baltagi and Griffin, 1997].

$$dY_t/Y_t = \alpha\theta(dK_t/Y_t) + \beta\theta(dL_t/L_t) + \mu\theta(dG_{Ft}/Y_t) + [v/(1+\delta)]\theta(dF_t/F_t)(X_t/Y_t) + z\theta(dF_t/F_t)(R_t/Y_t) + \omega\theta(dX_t/X_t)(R_t/Y_t) + [\delta/(1+\delta)]\theta(dX_t/X_t)(X_t/Y_t) + (1 - \theta)dY_t/Y_{t-1} \quad \text{1.23}$$

Decomposing the Spillover Effects

The infrastructure and export sectors spillover effects in both equation (1.19) and equation (1.23) can be decomposed into five components. Four of them are common to both equations while the fifth one is applicable only to equation (1.23).

1/ Gains due to positive externalities from the infrastructure sector to the export sector (adjusted for marginal productivity differences between export and non-export private sector (δ)): $[v/(1+\delta)](dF_t/F_t)(X_t/Y_t)$;

2/ Gains due to positive externalities from the infrastructure service to the non-export private sector: $z(dF_t/F_t)(R_t/Y_t)$;

3/ Gains due to positive externalities from the export to the non-export private sector: $\omega(dX_t/X_t)(R_t/Y_t)$; and,

4/ Gains due to higher factor productivity in the export sector $[\delta/(1+\delta)](dX_t/X_t)(X_t/Y_t)$.

Moreover, equation (1.23) incorporates the fifth component, $(1 - \theta)\, dY_t/Y_{t-1}$, . In this model, it is assumed that expected growth in infrastructure services enhances private sector capital accumulation.

Equations (1.19) and (1.23) are nested equations, which encompass the neo-classical one-sector models, which are specified as equation (1.24) and equation (1.25) below.

Models for Empirical Estimation

By adding a constant and an error term in each equation, equations (1.19) and (1.23) will be used for the empirical analysis in the rest of the paper. In addition, equations (1.24) and (1.25) will be estimated separately for comparison purpose.

The One-Sector models

1. Without Externalities from Expected Infrastructure Output Growth

$$dY_t/Y_t = \alpha(dK_t/Y_t) + \beta(dL_t/L_t) + \mu(dG_{Ft}/Y_t) \quad \text{..... 1.24}$$

2. With Externalities from Expected Infrastructure Output Growth

$$dY_t/Y_t = \alpha\theta(dK_t/Y_t) + \beta\theta(dL_t/L_t) + \mu\theta(dG_{Ft}/Y_t) + (1-\theta)dY_t/Y_{t-1} \quad \text{..... 1.25}$$

where, the subscript 't', in the equations (1.24) and (1.25) represents time.

1.5 Data Sources and Analysis

1.5.1 Data Description and Variable definition

The chapter conducts a panel data analyses on selected countries drawn from Africa, Asia and Latin America. Infrastructure service output (F) is defined based on World Bank's "core infrastructure" definition [Mamatzakis and Albala, 2004 and Wang, 2002], which includes electricity, water, transport, storage and communication. The data are drawn from United Nations Statistics database, IMF Fiscal Affairs Department (for the breakdowns of private and government investment), the National Bank of Ethiopia database and the Ministry of Finance and Economic Cooperation Database. The estimation period covers 1980-2011. All variables are in real terms. Real non-export private sector output (R) is computed as a residual: deducting the sum of real exports of goods and services (X) and real infrastructure service outputs (F) from the real GDP (Y)[21].

Change in private real physical capital (dK) is computed as a residual by deducting government capital formation (dG) from total gross capital formation (dK_T). As done by Feder (1983) and Ram (1987), and most other researchers, population series is used for labour input (L), as time series data for employment is not available in most developing countries. The limitation of using a population series is that it implicitly assumes the ratio of employed-to-total-population and the inter-sector structure of employment in the economy

[21] From the relationship Y = F + X + R in equation (1.3), the R series is derived as: R = Y – (F + X).

Table 1-1. Data Sources and Variable Definitions 1/

Variable	Definition of the Variable	Source of Data
Y	Real gross domestic Product at Market Prices at national currency unit (NCU)	UN Statistics database, except for Ethiopia. The Ethiopian data is obtained from MOFED
dK_T	Total real gross fixed capital formation at NCU	"
G	Real government gross fixed capital formation at NCU	Computed using the respective country ratios of government fixed capital formation to total gross fixed capital formation obtained from IMF Fiscal Department
dK	Real gross private fixed capital formation at NCU	Computed as a difference between dK_T and G
L	Total labour force	Total population obtained from UN Statistics
X	Real exports of goods and non - factor services at NCU	UN Statistics database, except for Ethiopia. The Ethiopian data is obtained from MOFED
F	Infrastructure output (includes transport, storage, communication, electric, gas and water supply)	"
R	Real private non-export sector output	Computed as: R = Y-X-F

1/ All nominal values are converted into real values using the respective countries' GDP deflator obtained from UN Statistics database.

remained constant throughout the estimation period. This, is a less plausible assumption, particularly in the fast growing economies of East Asia, Africa and Latin America, where the structure of employment changes relatively fast towards the modern sector.

Table 1-2. Descriptive Analysis of Variables unused in the Model: 1982-2011

	East Asia				Africa				Latin America			
	Mean	Max.	Min.	Std. Dev.	Mean	Max.	Min.	Std. Dev.	Mean	Max.	Min.	Std. Dev.
dY/Y	5.8	15.3	-15.1	3.5	3.6	25.1	-95.4	7.8	2.8	15.5	-25.1	5.6
dK/Y	21.4	34.4	9.0	6.23	10.6	29.4	1.8	5.4	16.1	24.7	7.4	3.7
dL/L	2.3	8.8	-1.7	1.3	2.5	17.2	-91.2	6.4	2.9	7.8	-1.2	1.6
G/Y	8.1	21.0	2.1	3.7	7.0	19.2	0.9	3.8	5.2	21.7	0.3	4.2
dF/F	6.6	23.6	-28.1	5.4	2.3	100.0	-648.6	47.9	2.1	32.8	-55.1	13.2
dF/F*F/Y	0.6	1.8	-1.8	0.5	0.4	17.2	-8.5	1.5	0.3	3.7	-3.8	1.1
dF/F*X/Y	2.3	16.2	-15.0	5.1	1.3	69.9	-600.6	43.8	1.6	23.1	-32.3	8.7
dF/F*R/Y	3.7	26.1	-20.7	5.0	0.6	25.2	-39.5	3.9	0.3	10.0	-20.7	3.8
dX/X	7.5	39.5	-48.0	9.5	3.7	55.5	-89.3	20.6	2.8	35.7	-76.2	16.5
dX/X*R/Y	2.2	20.0	-28.9	7.6	2.7	48.6	-78.6	16.4	1.6	24.4	-58.8	12.1
dX/X*X/Y	4.5	37.0	-35.9	7.8	1.0	18.1	-11.2	3.4	1.0	11.8	-13.8	3.7

Selection of countries for each region is mainly based on data availability and similarities in economic development. From Africa eight countries, namely Ethiopia, Ghana, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia are included in the sample while six countries are chosen from Asia, namely, India, Indonesia, Malaysia, Thailand and Singapore. Brazil, Chile, Peru and Venezuela are the four countries chosen from Latin America.

Table 1.2 indicates large disparities between growth rates of East Asia, Africa and Latin America. East Asia was growing 1.6 times faster than Africa and twice as fast as Latin America. The average growth rate between 1982 and 2011 was 5.8 percent for East Asia while it was 3.6 percent and 2.8 percent for Africa and Latin America, respectively. In terms of private investment, again, East Asia performed far better than Africa and Latin America. Private gross fixed investment averaged 21.4 percent of GDP in East Asia followed by 16.1 percent in Latin America and 10.6 percent in Africa. Moreover, East Asia has the highest investment rate in infrastructure compared with the other two regions, investing 8.1 percent of its GDP on the sector annually while the eight countries in Africa invest 7.0 percent of their GDP and Latin America 5.2 percent only. Accordingly, total gross fixed investment amounted to 29.5 percent of GDP in East Asia, 17.6 percent in Africa and 21.3 percent in Latin America.

A wide disparity is also evident between the three regions in terms of infrastructure output growth and export of goods and services growth. Real infrastructure output services were growing at an average rate of 6.6 percent in East Asia, 2.3 percent in Africa and 2.1 percent in Latin America. On the other hand, real export growth averaged 7.5 percent in East Asia, 1.7 percentage points beyond real GDP growth rate, while, in Africa and Latin America, real export growth rates remain closer to the real GDP growth rate, i.e., 3.7 percent and 2.8 percent, respectively, despite the low export bases in these regions. Consequently, East Asian countries have much higher export-to-GDP ratios than African and Latin American countires. For instance, between 1980 and 2011, exports accounted for 63 percent of GDP in East Asia, on average, whereas, in Africa and Latin America, exports accounted for 17.3 percent and 22.2 percent, respectively.

1.5.2 Unit Root Analysis

Before proceeding to estimation of the model, the time series properties of the variables are examined. Modern time series theories argue that if the variables are non-stationary, the OLS regression method could be inappropriate because the usual "t" and "F" tests become meaningless, and the estimated coefficients would be "spurious" [Greene 2000]. We perform the unit root test using five types of panel unit root tests: Levine, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003), Fisher-type tests using ADF and PP tests.

Let's assume the following ADF specification,

$$\Delta y_{it} = \alpha y_{it-1} + \sum_j \beta_{ij} \Delta y_{it-j} + X'_{it}\delta + u_{it} \quad \text{j= 1,..., } \rho \qquad \text{..... 1.30}$$

The first two tests, i.e., Levine, Lin and Chu (2002), and Breitung (2000) assume that there is a common unit root process, i.e., $\alpha = \rho - 1$, across cross-sections. On the other hand, the last three tests - Pesaran and Shin (2003), and Fisher-typ tests using ADF and PP tests - allow for individual unit root process so that ρ_i may vary across cross-sections [Maddala and Kim, 1998 and Baltagi, 2005]. These tests are simply multiple-series tests that have been applied to panel data structure where the presence of cross-section generates 'multiple series' out of a single series.

The results of the unit root tests conducted on the panel data of Africa, Asia and Latin America indicate that all the variables in the model are stationary in levels. Private fixed capital formation as a ratio of GDP (dK/Y), fails to pass the stationarity test four out of the five tests in the case of East Asia. However, since it passes the Breitung t-stat test at one percent level, we can reasonably assume that the variable is stationary. On the other hand, government fixed capital formation as a ratio of GDP (G/Y) fails to pass only two out of five tests in East Asia. With only stationary variables, OLS technique could be applied.

Therefore, the next question is whether the countries in each category qualify to be pooled together in a single equation. In this case, the appropriate technique is a covariance analysis.

Table 1-3: East Asia - Unit Root Test Results at Level

	Common Unit Root Process			Individual Unit Root Process					
	Levin, Lin & Chu t*		Breitung t-stat	Im, Pesaran and Shin W-stat		ADF - Fisher Chi-square		PP - Fisher Chi-square	
	With Constant	With constant and trend	With constant and trend	With Constant	With constant and trend	With Constant	With constant and trend	With Constant	With constant and trend
dY/Y	-8.041***	-8.088***	-7.602***	-7.218***	-7.181***	74.907***	69.982***	75.6***	182.9***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dK/Y	-0.429	-0.971	-2.727***	-0.178	-0.704	15.928	15.286	11.900	14.400
	(0.334)	(0.166)	(0.003)	(0.429)	(0.241)	(0.318)	(0.359)	(0.618)	(0.419)
dL/L	-5.649***	-5.612***	-4.852***	-4.945***	-5.584***	52.362**	55.891***	67.0***	106.4***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
G/Y	-1.775**	-0.817	-1.539*	-1.314*	-0.714	20.999	18.719	16.3	9.000
	(0.038)	(0.207)	(0.062)	(0.095)	(0.238)	(0.102)	(0.176)	(0.298)	(0.830)
dF/F	-6.633***	-7.114***	-3.548***	-7.269***	-9.732***	76.028***	96.107***	76.2***	225.7***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dF/F*F/Y	-7.230***	-6.899***	-3.829***	-7.837***	-8.768***	81.907***	84.728***	82.2***	202.6***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dF/F*R/Y	-0.941	-7.259***	-3.624***	-3.126***	-8.806***	38.262***	92.639***	75.2***	160.3***
	(0.173)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
dF/F*X/Y	-5.887***	-4.282***	-1.583*	-7.473***	-6.956***	78.374***	66.632***	83.6***	137.1***
	(0.000)	(0.000)	(0.057)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dX/X	-12.875***	-10.291***	-8.984***	-11.917***	-10.130***	129.860***	100.406***	134.7***	118.7***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dX/X*R/Y	-6.286***	-8.113***	-5.344***	-7.676***	-8.938***	84.452***	88.626***	104.5***	94.2***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dX/X*X/Y	-11.160***	-12.407***	-9.924***	-10.800***	-12.770***	117.731***	135.226***	135.6***	176.0***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 1-4: Africa - Unit Root Test Results at Level

	Common Unit Root Process			Individual Unit Root Process					
	Levin, Lin & Chu t*		Breitung t-stat	Im, Pesaran and Shin W-stat		ADF - Fisher Chi-square		PP - Fisher Chi-square	
	With Constant	With constant and trend	With constant and trend	With Constant	With constant and trend	With Constant	With constant and trend	With Constant	With constant and trend
dY/Y	-7.770***	-9.489***	-2.279***	-7.945***	-10.248**8	97.319***	117.252***	102.1***	112.3***
	(0.000)	(0.000)	(0.011)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dK/Y	-0.329	-2.899***	-1.852**	-0.917	-2.478***	31.100***	35.147***	32.1***	37.4***
	(0.371)	(0.002)	(0.032)	(0.180)	(0.007)	(0.013)	(0.004)	(0.010)	(0.002)
dL/L	-10.983***	-9.938***	-4.826***	-12.585***	-11.729***	98.844***	328.193***	83.3***	316.6***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
G/Y	-3.722***	-2.236**	-2.695***	-4.525***	-3.377***	50.406***	41.657***	44.3***	38.2***
	(0.000)	(0.013)	(0.004)	(0.000)	(0.004)	(0.000)	(0.004)	(0.000)	(0.001)
dF/F	-10.239***	-10.030***	-2.780***	-9.347***	-10.356***	112.507***	114.574***	124.1***	137.7***
	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dF/F*F/Y	-12.351***	-10.494***	-2.022**	-12.382***	-11.324***	145.479***	120.946***	140.2***	137.4***
	(0.000)	(0.000)	(0.022)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dF/F*R/Y	-10.418***	-10.161***	-3.590***	-9.462***	-10.515***	113.964***	115.224***	125.5***	134.5***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dF/F*X/Y	-8.979***	-8.029***	-0.062	-9.644***	-9.748***	116.595***	109.248***	126.2**	140.7***
	(0.000)	(0.000)	(0.475)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dX/X	-11.129***	-10.403***	-9.583***	-12.854***	-12.352***	152.254***	142.800***	150.3***	522.1***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dX/X*R/Y	-9.887***	-9.420***	-5.811***	-10.924***	-10.330***	125.996***	116.377***	126.2***	163.2**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dX/X*X/Y	-11.082***	-11.048***	-4.524***	-12.439***	-12.980***	144.849***	155.514***	146.6***	376.8***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table1-5: Latin America - Unit Root Test Results at Level

	Common Unit Root Process			Individual Unit Root Process					
	Levin, Lin & Chu t*		Breitung t-stat	Im, Pesaran and Shin W-stat		ADF - Fisher Chi-square		PP - Fisher Chi-square	
	With Constant	With constant and trend	With constant and trend	With Constant	With constant and trend	With Constant	With constant and trend	With Constant	With constant and trend
dY/Y	-3.213***	-9.092***	-1.460*	-5.696***	-7.051***	45.514***	93.457***	70.0***	98.2***
	(0.000)	(0.000)	(0.072)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dK/Y	-2.217***	-2.625***	-1.750**	-2.190***	-2.122**	17.509**	16.836**	15.5**	9.8
	(0.013)	(0.004)	(0.040)	(0.014)	(0.017)	(0.025)	(0.032)	(0.050)	(0.276)
dL/L	-3.058***	-5.167***	-3.495***	-3.121***	-4.600***	23.727***	33.355***	38.1***	30.6***
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)
G/Y	-4.070***	-1.874***	0.372	-5.176***	-2.400***	42.690***	18.374**	26.4***	18.3**
	(0.000)	(0.031)	(0.645)	(0.000)	(0.008)	(0.000)	(0.019)	(0.000)	(0.019)
dF/F	-3.480***	-3.291***	-3.379***	-4.514***	-4.133***	34.915***	32.817***	50.8***	42.5***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dF/F*F/Y	-4.725***	-4.478***	-4.822***	-4.846***	-4.520***	37.757***	35.498***	56.9***	49.7***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dF/F*R/Y	-3.031***	-3.160***	-2.970***	-4.223***	-3.969***	32.485***	31.758***	48.6***	39.8***
	(0.001)	(0.001)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dF/F*X/Y	-4.446***	-4.795***	-3.063***	-5.113***	-6.418***	40.116***	47.186***	56.0***	50.8***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dX/X	-4.577***	-7.707***	-4.545***	-4.703***	-7.054***	36.778***	51.946***	62.3***	54.0***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dX/X*R/Y	-4.155***	-7.954***	-4.644***	-4.609***	-7.641***	36.026***	56.726***	64.4***	57.6***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dX/X*X/Y	-5.115***	-7.260***	-3.926***	-4.673***	-6.133***	36.513***	44.616***	59.7***	50.5***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

1.5.3 Analysis of Covariance

Hsiao (2003, p 14) argues that in a panel least-square estimation, it is assumed that "...the regression parameters take values common to all cross-sectional units for all time periods". If this assumption is not valid, the panel least-square estimates lead to false inferences." Following Hsiao (2003, p.15), the chapter "assumes that parameters are constant over time, but can vary across individuals"

$$y_{it} = \alpha_i + \beta_i' x_{it} + u_{it}, \quad i = 1, ...,N, \quad N = 1,...,T, \qquad 1.31$$

Then we can test the following two hypotheses:

Hypothesis 1 (H_1): regression slope coefficients are identical, and intercepts are not. That is,

$$y_{it} = \alpha_i + \beta' x_{it} + u_{it} \qquad 1.32$$

Hypothesis 2 (H_2): Both slope and intercept coefficients are the same. That is

$$y_{it} = \alpha + \beta' x_{it} + u_{it} \qquad 1.33$$

The F-test for H_1 is:

$$F1 = \{(S2 - S1)/[(N-1)K]\}/\{S1/[NT - N(K+1)]\}$$

The test for H_1 is conducted against the unrestricted regression, which assumes both intercept, and slopes are heterogeneous. Where, S represents residual sum of squares (RSS). S1 represents unrestricted RSS (in this case, both intercept and slope are heterogeneous) and S2 stands for the restricted sum of square. Rejecting H_1 implies that the regression's slope coefficients and intercepts are heterogeneous.

The F-test for H_2 is:

$$F1 = \{(S3 - S2)/ [(N-1)]\}/ \{S2/ [N (T-1) -K]\}$$

In this case, the unrestricted RSS is S2 and the restricted RSS in line with H_2 is S3

Results of the covariance analysis are presented in Table 1.1 below. The analysis indicates hypothesis one (H_1) is rejected at 1 percent level of significance in the case of

Africa and Latin America. Only in the case of the East Asian group that the hypothesis is not

Table 1-6. Analysis of Covariance

		Degrees of Freedom		Actual F-ratios
		Numerator	Denominator	
	H1: Constant Slope but Heterogeneous intercept			
1	East Asian Countries	48	111	1.17
2	African Countries	72	186	1.68***
	Using dummies: 1984 for Ethiopia and 1993&94 for Rwanda	70	126	1.17
3	Latin American Countries	32	92	1.52**
	Using dummy for 1983	27	78	1.29
	H2: Constant Slope and Homogeneous Slopes			
1	East Asian Countries	6	202	2.82***
2	African Countries			
	Using dummies: 1984 for Ethiopia and 1993&94 for Rwanda	8	222	1.25
3	Latin American Countries			
	Using dummy for 1983	4	103	0.31

rejected. Rejecting H_1 implies countries do not have common constant parameters. This suggests that one should conduct individual time-series estimation on each county data. However, on closer inspection it is clear that the heterogeneity stems from a few large exogenous shocks. Hence, intercept dummies are used to capture the outliers.

Accordingly, when the year 1984 of the Ethiopian famine and the years 1993 and 1994 representing the periods of the build-up for Rwandan Genocide and the occurrence of the actual Genocide are dummied out, the test for Africa fails to reject H_1. For Latin America, the year 1983 in which most of the countries in the group experienced significant fall in national output is dummied.

1.6 Methodology of Estimation

As illustrated in section (1.3), equation (1.19) is a simple growth model while equation (1.23) is a dynamic one. This section presents the estimation techniques applied in each case and tries to indicate some of the limitations of these techniques.

1.6.1 Least Square Dummy Variable (LSDV) Estimators vs. Generalized Method of Moments (GMM) Estimators

For the simple growth model, i.e. equation (1.19), the least square dummy variable (LSDV) model, by allowing for fixed country specific effects, is applied. The LSDV model is a classical regression model that is built on the standard assumptions that all the explanatory variables are exogenous. The fixed country specific effects model assumes that wealthier countries in the panel could spend more on public infrastructure investment. Moreover, a feasible GLS specification is applied to take care of possible cross-section heteroskedasticity.

On the other hand, in the case of the dynamic growth model, specified in equation (1.23), the presence of serial correlation in the error term or the presence of a random country effect renders the lagged dependent variable correlated with the error term. It is argued that estimation of a dynamic model with LSDV model might lead to inconsistent estimates, even if all the explanatory variables are uncorrelated with the error components [Baltagi and Griffin, 1997]. The LSDV performs well only when the time dimension of the panel is large [Judson and Owen, 1999]. In this case, most panel data econometrics literature recommend applying a GMM estimator. However, the problem with the GMM estimator is that "when the time dimension gets large ($T > 20$), as it is often the case in macroeconomic data, computational requirement increases substantially and a GMM estimation using all available instruments may not be practical to implement" [Judson and Owen, 1999, p.13]. Using Monte Carlo simulation, Judson and Owen (1999) found that for sufficiently large T, i.e., T=30, LSDV performs better than a GMM estimator even in the case of unbalanced panel. The GMM estimator is found to perform better in a panel with $T < = 20$. Given that the time dimension in our model is sufficiently large, i.e., $T = 31$, we find that the LSDV model, with a feasible GLS setting, is the appropriate model. Hence, the LSDV estimator is applied to the dynamic growth model as well.

1.6.2 Fixed Effect vs. Random Effect

Literature on panel data argues that the fixed effect model is a reasonable approach when one can be confident that the differences between units can be viewed as parametric shifts of the regression function. On the other hand, if it is believed that

sampled cross-section units are drawn from a large population, it might be more appropriate to view individual specific constant terms as randomly distributed. In this chapter, the samples are drawn from a limited population of countries in each region. They are chosen as countries of interest (not random) [Judson and Owen, 1999]. Moreover, differences across countries are expected to be mainly related to initial conditions such as wealth and resource endowment. The richer the country is the more it is expected to spend on public infrastructure investment [Greene, 1999]. A positive correlation is expected between the country-specific effects and public infrastructure. In this case, it is more appropriate to assume that the differences between units are parametric shifts. Therefore, in this chapter, a fixed-effect model is applied, allowing for changing intercepts across-countries in the panel.

Sections (1.7.1) and (1.7.2) present the estimation results of the one-sector and the three-sector models, with- and without-expected-infrastructure-output-growth effects, respectively. However, as the estimated results of parameters of interest are almost similar in both models, i.e., equation 1.19 and equation 1.23, the interpretation of the estimated elasticity parameters proceeds with the model without-the-expected-infrastructure-output-growth effect, to avoid confusion.

1.7 Estimation Results

1.7.1. The One-sector model

Estimation results of the one-sector model are presented in Table 1.7 below. The table presents estimation results from both equations (1.19) and (1.23). Several results are worth mentioning. First, private capital stock plays a significant role in explaining growth in all the three regions under study. The elasticity coefficients of dK/Y are found significant at 1 percent significance level in the case of East Asia and Africa while it is significant at 10 percent in Latin America. This confirms the findings of many growth accounting models in developing countries [see Wang, 2002; Wang and Yao, 2002; and Young, 1995]. The results illustrate that a one percent increase in the stock of private capital leads to a 0.24 percent, a 0.17 percent and a 0.18 percent increase in real GDP in East Asia, Africa, and Latin America, respectively. Second, labour input is found significant only in the case of East Asian countries. The latter

Table 1-7: One-sector Model with Infrastructure Capital Stock

	Without Externalities from Expected Infrastructure Output Growth			With Externalities from Expected Infrastructure Output Growth		
	East Asia	Africa	Latin America	East Asia	Africa	Latin America
dK/Y	0.243***	0.173***	0.182*	0.172***	0.164***	0.055
	(7.450)	(3.483)	(1.795)	(6.123)	(3.179)	(0.437)
dL/L	0.495**	-0.060	-0.159	0.434***	-0.062	-0.187
	(1.968)	(-0.451)	(-0.591)	(2.819)	(-0.463)	(-0.725)
dGF/Y	-0.243**	0.199***	-0.122	-0.226***	0.201***	-0.092
	(-2.469)	(2.730)	(-0.917)	(-2.928)	2.710	(-0.5463)
dY_t/Y_{t-1}				0.205***	0.070	0.095
				(3.859)	(0.968)	(1.523)
Constant	3.340***	1.222	1.366	3.229***	1.079	3.080
	(3.992)	(1.465)	(0.738)	(6.010)	(1.282)	(1.418)
DUMM_83			-8.294***			-8.254***
			(-3.431)			(-3.201)
DUMM_84		-10.723			-11.044	
		(-1.550)			(-1.568)	
DUMM_93		-13.557			-13.942	
		(-0.878)			(-0.897)	
DUMM_94		-26.178***			-26.993***	
		(-7.441)			(-7.436)	
DUMM_97	-2.526*			-2.581**		
	(-1.870)			(-2.001)		
DUMM_98	-7.741***			-7.592***		
	(-3.927)			(-3.733)		
Obs.	177	221	125	177	221	122
Adj. R2	0.374	0.257	0.165	0.410	0.264	0.166

implies that labour provides no constraint on output as it might be in surplus in Africa and Latin America. .

Third, infrastructure capital accumulation has a positive and significant direct effect only in the case of Africa with an elasticity of 0.20. A one percent increase in infrastructure capital stock leads to a 0.2 percent increase in aggregate output. This implies that public infrastructure capital accumulation has a strong direct effect on economic growth in Africa. This result supports the findings of Calderon and Serven (2003) who argue that infrastructure is under-provided in Sub-Saharan Africa. However, as the model does not capture the indirect contribution of infrastructure capital, i.e, the provision of its services to private sector output, the model cannot

answer weather the underprovisioning is in terms of underinvestment in new infrastructure networks or poor infrastructure services. On the other hand, a puzzling result is found for East Asia. In the latter, the direct contribution of infrastructure is found to be significant but negative. It implies a one percent incremental spending on new infrastructure investment might result in a 0.23 percent reduction in the national output. Using a pooled data analysis of five newly industrialized countries (NICs), namely Japan, Hong Kong, Korea, Malaysia, Singapore, Thailand and Taiwan, covering the period 1979-1998, Wang (2002) found an insignificant coefficient for public infrastructure capital. However, in the individual country estimations, Wang (2002) found negative, but insignificant, coefficients for public infrastructure capital in the case of Japan, Malaysia and Singapore. He argues that the results might imply inefficient utilization of infrastructure capital in the region[22]. In the Latin America region, the direct contribution of public infrastructure capital is found insignificant.

Finally, the low overall fit of the model across all the three regions, as measured by the adjusted R^2, indicates that the direct contributions of factor inputs, including public capital stock, in explaining variations in aggregate output, is limited. The overall fit of the model is only 25.7 percent in Africa, 37.4 percent in Asia and 16.7 percent in Latin America. This implies that much of the variations in growth are explained by the respective residuals [Agenor and Montiel, 1999].

1.7.2 The Three-Sector Model

Table 1.8 presents the estimation results of the three-sector model. The major findings of the three-sector model, compared with the conventional one-sector model, are: first, what matters for private sector output and economic growth is the efficient provisioning of infrastructural services rather than a simple accumulation of infrastructure capital. For instance, infrastructure spillover variables (dF/F*X/Y) and (dF/F*R/Y) are found significant at one percent level in East Asia with elasticity coefficients of 0.21 and 0.22, respectively. This has solved the puzzle in the one-sector model. Getting a significant but negative coefficient for G_F/Y in the one-sector model was puzzling because,

[22] Wang (2002) argues that one reason for the inefficient utilization of public capital is that a large portion of the infrastructure sector is operated either monopolistically or by the government.

recently, consensus seems to emerge in the empirical literature that infrastructure has played a prominent role in enhancing growth in the East Asia region [see Chen, 1997;

Table 1-8. Three Sector-Infrastructure and Export Spillover Models

	Without Externalities from Expected Infrastructure Output Growth			With Externalities from Expected Infrastructure Output Growth		
	East Asia	Africa	Latin America	East Asia	Africa	Latin America
dK/Y	0.201***	0.178***	0.222***	0.203***	0.206***	0.101
	(8.624)	(4.055)	(2.533)	(7.422)	(4.109)	(0.821)
dL/L	0.398***	-0.162	0.031	0.395***	-0.106	-0.019
	(2.934)	(-1.501)	(0.161)	(2.942)	(-0.931)	(-0.105)
dGF/Y	-0.281**	0.050	0.042	-0.283**	0.112	-0.017
	(-2.171)	(0.606)	(0.214)	(-2.129)	(1.262)	(-0.091)
dF/F*X/Y	0.213***	-0.164	0.176	0.214***	-0.215*	0.198
	(2.768)	(-1.419)	(0.512)	(2.665)	(-1.780)	(0.637)
dF/F*R/Y	0.218***	0.129***	0.175	0.223***	0.115***	0.180
	(3.753)	(3.229)	(0.890)	(3.441)	(2.589)	(0.977)
dX/X*R/Y	0.015	0.009	-0.070	0.016	0.027	-0.064
	(0.618)	(0.407)	(-1.497)	(0.482)	(1.051)	(-1.417)
dX/X*X/Y	0.107**	0.139*	0.555***	0.107**	0.048	0.550***
	(2.396)	(1.720)	(3.517)	(2.281)	(0.507)	(3.539)
dY_t/Y_{t-1}				-0.007	-0.030	0.117*
				(-0.122)	(-0.730)	(1.706)
Constant	1.554	2.107***	-1.437	1.561	1.409	0.629
	(1.154)	(2.504)	(-1.122)	(1.309)	(1.532)	(0.418)
DUMMY_83			-8.348***			-8.208***
			(-4.380)			(-4.258)
DUMMY_84		-8.770**			-8.852**	
		(-2.074)			(-2.131)	
DUMMY_93		-13.830***			-13.302***	
		(-2.693)			(-2.633)	
DUMMY_94		-28.722			-38.029	
		(-1.349)			(-1.611)	
DUMMY_97	-3.128***			-3.141***		
	(-13.263)			(-13.312)		
DUMMY_98	-7.915***			-7.939***		
	(-26.999)			(-26.438)		
Obs.	163	207	114	163	207	114
Adj. R2	0.586	0.718	0.316	0.583	0.743	0.329

Todaro and Smith, 2009; and Feder, 1983]. The results from the one-sector model, however, seem to nullify the consensus. Now, by splitting the contribution of

infrastructure into direct (through capital accumulation) and indirect (through provisioning of infrastructure services), the puzzle seems to be solved in the three-sector model. The results from the three-sector model confirm that, in fact, infrastructure plays a significant role in enhancing growth indirectly through its services, validating the consensus in the literature.

Moreover, in Africa, the fact the G_F/Y is insignificant while dF/F*R/Y is found significant at one percent significance level, in the three-sector model confirms that it is the quality and availability of infrastructure services that matters most in the region rather than accumulation of infrastructure capital. On the contrary, the G_F/Y is found significant and positive in the one-sector model simply because the model cannot separate the contribution of infrastructure services growth from that of infrastructure capital accumulation. It is important to note, however, that the results do not necessarily imply infrastructure capital accumulation does not contribute to economic growth because it is difficult to think of growth in infrastructure services without infrastructure capital accumulation, at least in the long run. It only implies, in terms of the long-term dynamics, the direct contribution of infrastructure is insignificant compared with availability of its services because it tends to be either oversupplied or inefficiently utilized.

Second, finding positive and significant coefficients for the infrastructure spillover variables (dF/F*X/Y) and (dF/F*R/Y) in East Asia confirm the presence of complementarities between public infrastructure and the exports sectors, and between the infrastructure and the non-export private sectors in the region. On the other hand, in Africa, the infrastructure spillover is found significant only in the case of private sector production to the domestic market. These results indicate the presence of a market failure in developing countries. Infrastructure seems to play little role in enhancing exports in Africa. This might be because most African countries depend on the exports of primary commodities, which are less integrated with domestic economic activities. In Latin America, the infrastructure spillovers are found to be insignificant. The implication of these findings is that developing countries need a well-devised infrastructure development strategy to enhance economic growth.

Third, presence of marginal productivity differences between the export sector and the non-export sector is confirmed across all regions. The dX/X*X/Y variable is found

to be significant and positive in all the three regions. The results imply that a reallocation of factor inputs from the non-export sector to the export sector makes them more productive, which suggests that, in developing countries, an export-oriented development strategy produces an optimal growth than the inward-oriented one.

Fourth, the export spillover to non-private export sectors (dX/X*R/Y) is found insignificant across all the three regions. This implies that the economy is benefiting little from the export spillover effect that is expected to enhance productivity and help to introduce internationally competitive modern management system in the non-export sector [Feder, 1983], apart from the resource reallocation effect. For the African counties, high dependency on exports of primary products, which have little contribution to vertical and horizontal integration in the domestic economy, could be one of the reasons for the lack of export externalities.

Fifth, private capital accumulation remains the main determinant of growth in all the three regions with elasticities between 0.18 and 0.22. On the other hand, except in East Asia, labour input and public infrastructure capital stock are found insignificant, confirming the result in the one-sector model.

Sixth, the power to explain variations in aggregate output has improved significantly in the three-sector model. For instance, in Africa, the overall fit of the model, as measured by adjusted R^2, increased from 25.7 percent in the one-sector model to 71.8 percent in the three-sector model; in East Asia, it increased from 37.4 percent to 58.6 percent; and, in Latin America from 16.5 percent to 31.6 percent.

Table 1.9 presents the spillover parameters and the marginal productivity difference parameter, which are computed from the estimated coefficients of the model. The spillover from infrastructure to the export sector parameter ‘v’ indicates that, in East Asia, a one percent increase in infrastructure output leads to a 0.27 percent increase in national output. This would happen by enhancing productivity of the export sector, creating economies of scale and/or reducing transaction costs in the export sector. In Africa and Latin America, the parameter is found insignificant illustrating the fact that these regions have given weak policy emphases on the link between infrastructure investment and exports.

On the other hand, the spillover from infrastructure to the domestic private sector parameter 'z' reveals that a one percent increase in infrastructure output increases national output by 0.26 percent in East Asia and by 0.13 percent in Africa by enhancing domestic private output growth. In Latin America, the domestic sector does not seem to benefit from investment in infrastructure spillover similar to the export sector.

Table 1-9. Spillover Effects of Public Infrastructure and Export Growth, and Marginal Productivity Differences[23]

	Spillover from infrastructure (F) to the export sector (X)	Spillover from infrastructure (F) to the non-export private sector (R)	Spillover from export (X) to the non-export private sector (R)	Marginal productivity difference between export and non-export private sectors
	Without Externalities from Expected Infrastructure Output Growth			
	v	z	ω	δ
East Asia	0.273***	0.262***	0.016	0.142***
Africa	-0.190	0.129***	0.009	0.161*
Latin America	0.395	0.175	-0.070	1.247***
	With Externalities from Expected Infrastructure Output Growth			
	(v)	(z)	ω	δ
East Asia	0.273***	0.262***	0.012	0.142**
Africa	-0.219*	0.112***	0.026	0.049
Latin America	0.595	0.204	-0.072	1.652***

The fourth column, in Table 1.9, reports the spillover effects of exports to non-private export sectors 'ω'. The parameter is found to be insignificant across all three regions. On the other hand, the estimated marginal productivity difference 'δ' reported indicates that factor inputs are more productive in the export sector than the rest of the economy across all the regions. The marginal productivity difference, as measured by 'δ', ranges between 14.2 percent in East Asia to 165 percent in Latin America. The relatively low productivity difference in East Asia compared with that in Africa and Latin America reflects the higher share of exports in aggregate economic output in the East Asian region. As the share of exports in aggregate output increases, the productivity gap between the export and non-export sectors narrows [Wang, 2002]. In Africa, the export

[23] The standard errors and t-ratios for the parameters are derived using the general property of variance: $Var(\beta_1*\beta_2) = \beta_1^{*2} Var(\beta_2) \Rightarrow Var(\beta_2) = Var(\beta_1*\beta_2)/ \beta_1^{*2}$

Standard deviation: $Se(\beta_2) = \sqrt{Var(\beta_1*\beta_2)/ \beta_1^{*2}}$; and t-ratio: $\beta_2/ Se(\beta_2)$

sector is 16 percent more productive than the non-export sector, implying that a reallocation of factor inputs from the non-export sector to the export sector makes them 0.16 percent more productive than when they are employed in the non-export sector. The result reported for the Latin American region, however, is surprising. The estimated ‘‘δ’ indicates that a shift of factor inputs from non-export to the export sectors increases the marginal products of those factor inputs by about 1.7 times[24]. Although this merits further investigation, the result might indicate the presence a strong dichotomy between the export sector and the rest of the economy in the region.

1.8 Summary and Policy Implication

In recent years, the role of infrastructure capital accumulation in enhancing economic growth has gained increased acceptance due to the increasing number of positive outcomes from studies on the area. However, literature still debate on the presence of long-term effect on economic growth. Some literature argue that infrastructure accelerates economic growth during the transitional dynamics towards the steady state. They associate the higher economic growth related to the period marked with acceleration of infrastructure capital accumulation to the transition dynamics. Others argue that infrastructure generates positive externalities to the rest of the economies through different channels. So, they argue that, it clearly affects long-term growth.

The source of such controversies has been lack of a well-designed analytical framework that captures the different channels through which infrastructure capital accumulation affects economic growth. The one-sector growth model captures only the direct effect. This channel is expected to produce positive coefficients as long as infrastructure capital is underprovided. The coefficient of infrastructure capital stock is found to be negative in Asia which suggests that it may be overprovided (Wang 2002) while it is found significant and positive in the case of Africa where it is believed to be underprovided [Calderon and Serven, 2003]. Hence, based on these results, the advice to Asian countries would be to pay more attention to the effective and efficient utilization of the existing infrastructure capital. On the other hand, the African countries should not to pay less attention to the quality and effective utilization of the existing

[24]This implies labour and capital productivities are higher by 2.6 times in the export sector compared to those in the non-export sector.

infrastructure resources while continuing to accumulate new public infrastructure capital.

The three-sector model developed in this chapter is able to solve the above puzzle by further splitting the private sector production function into exports, and non-export sectors and investigating if differences in the trade openness of countries determines the optimal long-term contribution of infrastructure capital accumulation on economic growth. The findings confirm that export-orientation of most of the Asian countries helped these countries to optimize the contribution of infrastructure capital accumulation on growth. The three-sector model identifies two more channels of infrastructure externalities, bringing the number of channels through which infrastructure affects growth increases from two to four. The first two channels are the capital accumulation and spill-over effect of infrastructure through which the latter affects growth directly. These channels are already identified in the two-sector model. The two newly identified channels are those through which infrastructure affects growth indirectly through capital accumulation and spillover effects of export growth. Therefore, this chapter finds that infrastructure capital accumulation and export development strategy are complementary to each other. This confirms the studies by Eastely and Serven (2003) and Rodriguez (2006) which argue that, in the 1980 and 1990s, African and Latin American countries failed to recognize importance of infrastructure development for the success of a strategy to open up their economies. So, one of the most important policy lessons to be drawn to Ethiopia from this chapter is that if the country wants to realize the optimal long-term effects of infrastructure investment on economic growth, infrastructure investment strategy must be supported by export-oriented policies or vice-versa.

Chapter 2

Stability and Determinants of the Demand for Money in Low Income African Countries with Structural Transformation: Theory and Evidence (A Co-integration Analysis)

2.1 Introduction

Stability of the demand for money is crucial to monetary policy making. Ethiopia's five-year Growth and Transformation Plan (GTP I), which was launched in 2011, assigns monetary policy a crucial role in ensuring macroeconomic stability and enhancing domestic saving mobilization. The plan envisaged to raise domestic savings by 5.5 percentage points of GDP within five years from 9.5 percent in 2010 to 15 percent in 2015 [Federal Democratic Republic of Ethiopia, 2010]. In an agricultural economy where more than 80 percent of the population makes a living in rural activities, particularly in farming, the success of this program depends on how fast the

structure of the economy changes from a consumption driven to a saving oriented one, and the speed of integration of the rural economy with the modern (monetized) economy.

Arize et al (1999, p.400) argues, "a theoretically coherent and robust money demand function is crucial for sound monetary policy formulation in less developed countries (LDCs) yet empirical work in this area is extremely sparse". Today, the importance of structural transformation, particularly in the production and trade sectors, is a burning issue in Africa. However, little attention has been paid regarding the implication of structural transformation process for macroeconomic policies, particularly on monetary policy. When countries are undergoing a structural transformation process, the latter is expected to be accompanied by a rapid monetization of the economy. Evidence from fast growing East Asian economies indicates that structural transformations in the production and trade sectors have been followed by a rapid monetization process, which led to an increase in the demand for money faster than the rate of growth of the economy (measured in nominal GDP). For instance, during the last three-and-half decades, from 1975 to 2011, the ratio of broad money supply to GDP (M2/GDP) has risen by 235 percent, from 38.3 percent in 1975 to 128.2 percent in 2011 in Thailand,; in Malaysia from 67 percent to 138 percent (a 106 percent increase), in Singapore from 59.5 percent to 128.6 percent (a 116 percent increase) and in South Korea from 28.5 percent to 131percent (a 360 percent increase)[25].

Similarly, in the nine fast growing African countries, evidence indicates that a structural transformation process has resulted in a rapid monetization, and has boosted the contribution of the financial sector to the national output. In these economies, the average M2/GDP ratio jumped from 18.2 percent in 1990 to 32.2 percent in 2013[26]. The fastest increases were registered in Ghana, which increased from 6.8 in 1990 percent to 24.5 percent in 2013 (increased by 260 percent), in Kenya from 24.5 percent to 55.8 percent (increased by 128 percent) and Uganda, from 8.4 percent to 24 percent (increased by 186 percent).

[25] The figures are computed from World Bank, World Development Indicators database.

[26]The nine countries include Ethiopia, Ghana, Kenya, Malawi, Nigeria, Rwanda, Tanzania, Uganda, and Zambia.

During a structural transformation process, the challenges to the financial sector are multifaceted. First, the central bank needs to have control over the stability of the demand for money during the entire transformation process and should have adequate knowledge of the types and magnitudes of the variables that affect it. Second, financial institutions such as banks, microfinance institutions and insurance agencies need to be made ready to respond to the demands of the changing dynamics in the production and trade structures of the economy [Chenery, 1986]. What makes the recent growth episodes in Africa particularly interesting is that, in line with the UN Millennium Goals, pro-poor and inclusive growth objectives have been given especial focus in the countries' development strategies. Governments in these countries have strong commitments to integrate the rural poor through massive investment in public infrastructure and human development. The expansion in infrastructure networks enhances the monetization process as it facilitates integration of the less monetized section of the society into the modern one, by creating easy access to the product and money markets and, consequently, enhancing specialization and division of labour in rural areas.

Ignoring the potential impact of the structural transformation process on the money market has at least two implications. First, monetary policy could potentially underestimate the extent of the demand for money in the long run, and the economy could be underprovided with the necessary long-term liquidity. The latter restrains long-term investment and growth by constraining economic activities and potential change in the structure of the economy. Second, the economy would also miss the opportunity to speed up the structural transformation process and create favourable conditions to enhance domestic savings[27]. Monetization could be speeded up through active government policies that aim at ensuring macroeconomic stability so that people could develop confidence on the value of money [see McLoughlin and Nariaki, 2012]; enhancing access to finance, particularly to the rural people where economic activities are less monetized; and introducing new financial instruments (to encourage financial savings).

[27] Reluctance to recognize the effect of monetization could have high costs on the economy by making policy makers miss the opportunity to boost domestic savings, which is crucial to sustain economic growth (see McLoughlin and Nariaki, 2012).

The objective of this chapter is to analyze the implications of the current structural transformation process in rapidly growing countries in Africa, on the stability of the demand for money, using a panel data cointegration analysis and draw policy lessons for Ethiopia. Moreover, the chapter tries to fill the existing gap in the literature regarding the role of structural transformation on the demand for money and the conduct of monetary policy in rapidly growing least developed countries. To this end, the chapter devotes a section to a brief theoretical background on the link between structural transformation and the demand for money in LDCs. The chapter also explores the significance and limitations of both the conventional and non-conventional theoretical models in the literature review section.

The chapter employs a panel cointegration technique for the empirical analysis. As many African countries lack extended time series data, panel cointegration technique helps to exploit joint cross-section and time series variations, and is expected to lead to a better statistical inference [Banerjee and Carrion-i-Silverstre, 2011]. Individual country estimations are also conducted on two countries, namely Kenya and Rwanda, from the panel for which time series data is available from 1971 to 2011. The estimation on the Ethiopian data is postponed to Chapter 3 to avoid redundancy.

The rest of the chapter is organized as follows. Section 2.2 deals with motivation of the chapter; and section 2.3 presents a brief review of the literature on alternative theories and formulations of the demand for money. Section 2.4 discusses the theoretical background of the new model. Section 2.5 provides a brief analysis of the link between the structural transformation process and the demand for money. In section 2.6, the chapter outlines data and methodology. Panel data estimation results are presented in section 2.7. The chapter concludes in section 2.8 by giving a brief summary and policy recommendations.

2.2 Motivation of the Paper

Since the 1990s, many African governments have renewed their commitments to eradicate poverty and decided to take ownership of economic policies and growth strategies. Consequently, the economic growth dynamics have witnessed a rapid

change in many African countries[28]. Evidence suggests that quite a number of African countries are in a rapid process of structural transformation, which is reflected in a shift in the structure of production and trade in the economy. In many African countries, the share of agriculture has been falling while per capita rural income has been witnessing a rapid growth in recent years. For instance, between 1996 and 2011, the share of agriculture in gross domestic product (GDP) declined from 61.9 percent to 45.3 percent in Ethiopia and from 47.2 percent to 32.3 percent in Rwanda. On the other hand, real per capita rural output increased by about 55 percent in Ethiopia and by 65.5 percent in Rwanda during the same period. Rapid economic growth and the expansion of road, electricity, telecommunication, health, and education infrastructure into the rural areas have transformed the lives of a significant number of rural families. Year on year, the number of rural families who are able to afford paying for hired labour, transport, telephone bills, health expenses, education services, and consumption of industrially processed food and drinks is increasing.

The motivation of this chapter is, therefore, to investigate the impact of structural transformation on the monetization process in rapidly growing African countries with similar production and trade structure, and analyse its implication on the stability of the demand for money functions, using a panel cointegration analysis, and draw lessons to Ethiopia. Moreover, absence of adequate literature on the area with a focus on the African economies has also motivated the study. Existing literature on the demand for money focuses on advanced as well as East and South East Asian countries [Banafea, 2012; and Kumar, 2011]. Only limited amounts of research have been published on Sub Saharan Africa, excluding South Africa. The few studies available include Anoruo (2002) on Nigeria, Dagher and Kovanen (2011) on Ghana and Aschheim, et al (1989) on Ethiopia, Ghana, Kenya and Morocco. Moreover, these studies focus on the conventional determinants of demand for money. As a result, they fail to deal with the

[28] Following economic and financial sector reforms in the 1990s, many African countries achieved macroeconomic stability, particularly low inflation. As a result, interest rates are generally lower from the pre-1990 level, permitting private investment to flourish, and misalignments in exchange rates were also by and large corrected (McLoughlin and Nariaki, 2012) improving the external sector position. The surge in demand for primary commodities following the resurgence of the East and South East Asian countries has also contributed to improvement in the external sector position of many African countries.

particular challenges of structural transformation on the stability of money demand and the conduct of monetary policy.

2.3 Literature Review

The stability of the demand for money is crucial for monetary policymaking. The effectiveness of monetary policy depends on the stability of the money demand function and the ability to influence movements of the variables that determine it. Despite the fact that there are extensive volumes of theoretical literature on the area, consensus has not emerged yet on the factors that affect the demand for money. Moreover, the empirical literature is concentrated in advanced economies, not in countries where the production and trade structure is subjected to a rapid change. Therefore, the debates on the demand for money focus on three issues: one, the general functional form of and the determinants of the demand for money; two, endogeneity of money supply; and three, the stability and importance of the demand for money [for the detailed discussions please see Harris, 1985; Laidler, 1985; and Judd and Scadding, 1982].

2.3.1 The Mainstream Theories of the Demand for Money

2.3.1.1 The General Functional Form and Determinants of the Demand for Money

The literature on the general functional form of the demand for money could be grouped into two parts: transaction theories and portfolio or asset theories (Judd and Scadding, 1982)[29]. Transaction theorists argue that individuals' decisions to hold money are mainly determined by money's special use as a medium of exchange, i.e., its purpose to facilitate transactions (Laidler, 1985).[30] On the other hand, portfolio or asset theorists consider money just like any other assets such as gold, durable and non-durable goods and also financial assets such as bonds and equity such that the demand for money is

[29] This categorization helps to easily identify, one, which classes of theories are in favour of current income or wealth as a scale variable, and, two, which theories support the inclusion of opportunity costs in the demand for money function.

[30] Laidler (1985) argues, "Two peculiar and interrelated characteristics of money are usually emphasized in theories that set it apart from other goods. The first is that money is acceptable as a means of exchange for goods and services, and the second is that its market value is, if not always stable, then at least generally highly predictable, over short time period at least" [Laidler, 1985 p.41].

determined, not only by its own price, but also by the prices of such other assets [Judd and Scadding 1982; Friedman, 1970; Harris 1985 and Laidler, 1985]. Judd and Scadding (1982) describes that the transaction theorists are led by the inventory theoretic models of Baumol (1952) and Tobin (1956), and the asset or portfolio theorists are led by monetarists and new Keynesian.

2.3.1.1.1 The General Functional Forms of the Demand for Money

In the general functional forms of the demand for money, the two groups are known to differ on two issues, i.e., on the definition of money and factors that determine the demand for money. In a search for the best functional form of the demand for money, selecting the appropriate definition of money is important. Transaction theorists argue that the reason why individuals prefer to hold money over other assets is that money is universally acceptable as a medium of exchange in the exchange of goods and services (Laidler, 1985). So, only financial assets such as cash and checks that could directly be exchanged for goods and services would qualify as money. The transaction theorists consider financial assets such as saving and time deposits as near monies, but, they argue that these assets do not qualify to be defined as money because one cannot directly use them to pay for goods and services without first converting them into cash or checks, which involves transaction costs (both in time and finance). Hence, individuals prefer to hold the amount of money that is only enough to conduct transactions in a given period. According to this theory, a stable relationship exists only between narrowly defined money (M1), which includes only cash and checks, and economic activities [Tobin 1956 and Harris, 1985].

On the other hand, the asset (portfolio) theorists argue that money is like any other assets and the demand for it is similar to the demand for other financial and real assets, and individuals hold money not only to conduct transactions but also as a temporary abode for purchasing power. For instance, if the return on money is higher than the returns on other assets such as equity, bonds or durable goods which themselves serve as a temporary abode for purchasing power, individuals would prefer to hold money. Therefore, according to asset theorists, the decision to hold money is part of individuals' utility maximization problem. It is therefore highly likely that individuals could hold more money than they need for transaction purposes. Judd and Scadding (1982, p.994)

state, “money and other assets were viewed as alternative ways of holding wealth, each yielding some mix of explicit income and implicit, or non-pecuniary, services flows. In the case of money, these services presumably included the ease of making transactions that is at the heart of the transactions model.” Hence, for asset theorists a stable relationship exists between broadly defined money, which includes time and saving deposits at the minimum (M2), and economic activities.

2.3.1.1.2 Factors Determining the Demand for Money

The second point of debate is what factors determine the demand for these monetary aggregates (M1 or M2). Transaction theorists emphasize on the flow side of money. They argue that current income or total volume of transaction is the principal determinant of the demand for money, serving as a scale variable. Regarding the opportunity cost of money, they argue that only short term interest rates, particularly interest income on short-term financial assets such as Treasury bills, serves as an opportunity cost of money [Tobin, 1956; Laidler, 1985; Judd and Scadding, 1982]. Tobin (1956), for instance, argues that when individuals perceive that the disadvantage of holding transaction balances exceeds the advantage of holding it due to high interest rates, they decide to hold less money than average and make more frequent transactions. The general form of transaction theorists’ demand for money equation could be specified as follows:

$$Md = f(y, r)P \quad \ldots\ldots 2.1$$

where Md is the demand for narrow money, y is measured (current) income, r is the nominal interest rate for short term financial assets such as treasury bills and P is the general consumer price index.

On the other hand, the asset or portfolio theorists take the demand for money from the stock or the balance sheet perspective. They argue that individuals hold money not only to facilitate payment but also as part of assets or wealth portfolio. So, they prefer the scale variable to be some measure of wealth or permanent income (Friedman, 1970). With respect to opportunity costs, the asset theorists argue that the demand for money is affected by a variety of factors that influence individuals’ decisions to allocate their wealth among competing assets, money being one of them. The decision to hold

money is, therefore, part of the utility maximization problem. This implies that, not only the short term interest rate but also the long term returns to assets such as equity and bonds and expected return on durable goods are considered as opportunity costs. For instance, Friedman, one of the prominent portfolio theorists, formulates the demand for money function as follows [Friedman, 1970].

$Md = f(W, r_m, r_b, r_e, \Pi^e, h; u)P$ …… ……..……..……..... 2.2

where Md is the demand for money in nominal terms; P is the general price level; W is wealth; r_m is the expected nominal rate of return on money; r_b is the expected nominal rate of return on fixed-value securities; r_e is the expected nominal rate of return on equities; Π^e is the expected rate of change in prices, which is defined as [1/p][dp/dt]; h is the ratio of human to non-human wealth; and u is "a portmanteau symbol standing for whatever variables other than income may affect the utility attached to the services of money" [Friedman, 1970 p. 204]. However, regarding the various interest rates, Friedman (1970) argued that since all of them move in the same direction, they can be represented by one rate 'r'. For empirical estimation, Laidler (1985) specifies Friedman's demand for money function as follows.

$M = f(W, [r-r^f], \Pi^e, h; u)\ P$ …….....……. 2.3

where M, P, h and W are as defined in equation (2.2), r is the representative interest rate and r^f is expected interest rate, which is defined as 1/r(dr/dt).

2.3.1.2 Exogeniety of Money Supply

The effectiveness of monetary policy also depends on the determinants of money supply. A study of the demand for money is mainly to make predictions about the consequences of a change in its supply (Laidler, 1985). So, exogeneity of money supply is a necessary condition for the effectiveness of monetary policy. Keynesians argue that money supply is endogenously determined by government borrowing, and this makes it an ineffective monetary policy instrument. To illustrate this argument using a portfolio approach, let us assume that central banks want to increase money supply and one of the principal sources of the increase in money supply is government borrowing. However, according to Keynesians, government borrowing increases net

financial wealth of individuals, and the return for money will go down relative to the returns to other assets. This makes a reallocation of wealth among competing assets necessary. Consequently, individuals shift some of their wealth from money to other assets, and end up holding lower money balances than policymakers intended to, while, on the other hand, interest rate rises above what the policy makers targeted. When banks observe that individuals' net wealth has increased, they would be encouraged to create more money, pushing the money supply up while pushing the interest rate down. So, from the illustrations, it is clear that the endogeneity of the money supply makes the demand for money function unstable through the simultaneity effect[31]. Keynesians also invoke the liquidity trap argument to make their case about the ineffectiveness of monetary policy. Hence, Keynesians are in favour of targeting the interest rate using fiscal policy rather than using money supply as monetary policy instrument.

Monetarists admit that the money supply could be endogenous in the short run, as a change in the rate of growth of money supply would trigger an adjustment process from the old equilibrium of nominal income to a new equilibrium. For instance, Friedman (1970) explains that when the rate of growth of money supply gets higher than the trend due to the action of government to borrow money from the central bank, the action would induce a new adjustment process that would result in higher rates of growth of prices resulting mainly from an increase in the desired velocity of money, and a reallocation of wealth away from money balances. This would end up in a nominal income growth that exceeds the rate of growth of money supply. However, in the long term, a new equilibrium will be established for the nominal income growth at a new rate of growth of money supply, while the equilibrium rate of growth of real income remains unaffected. Hence, the monetarists argue that what is important for monetary policy is its long-term implication, as increase in money supply has a permanent effect on the stock of money [Friedman, 1970]. Currently, a general consensus seems to emerge on the long run exogeneity of money supply.

[31] Tobin argues that if government deficit financing occurs through money printing (called outside money), it would create new wealth of the private sector as long as it increases the stock of financial assets that are liabilities of the government. An increase in wealth, in turn, would have portfolio allocation effect. In addition, government spending would affect the demand for goods and services and therefore, it affects output. Others however argue that the effect of government borrowing on net wealth depends on how much government levied tax liabilities on individuals to repay interest expense. If government debt is non-interest bearing, the effect of government borrowing on net wealth is full. If on the other hand it is interest bearing the effect will be partial [Laidler, 1985].

2.3.1.3 The Stability and Importance of the Demand for Money Function

The debate on the stability of the demand for money and the relative importance of the money supply over the interest rate as a monetary policy instrument is an empirical question and it all depends on two issues. One, how stable and predictable are the existing determinants of the demand for money: for instance, if some of the factors that determine the demand for money are random and move unpredictably, the demand for money function becomes unstable. Two, if money supply is endogenous, monetary policy becomes ineffective despite the fact that the existing determinants of the demand for money are stable and predictable because the newly introduced financial assets cause the money demand function to shift due to the new money substitutes. Judd and Scudding (1982) argue that the financial innovation in the 1970s, i.e., the introduction of a variety of money substitutes such as electronic money, debit and credit cards and improved capital mobility, created instability in the demand for money function of advanced countries. As a result, some central banks re-examined the definition of money and tried to incorporate new monetary substitute in the monetary aggregate while others totally abandoned the use of monetary aggregates, and shifted to the interest rate as a monetary policy instrument [32][Kumar et al, 2010]. This claim has, however, been questioned by Bahmani-Oskooee and Rehman (2005), Rao and Kumar (2009b), Bahmani-Oskooee and Gelan (2009) and Yu and Gan (2009). Using the data from Asian countries, these authors have found no instability in the demand for money function, including the 1970s, using alternative estimation methods" [Narayan, et al, 2009 p.1].

[32] Poole (1970) suggests that central banks should target interest rate when the demand for money is unstable. So, according to Poole (1970) "the selection of monetary policy instrument should depend on the stability of the demand for money" (Kumar 2011)

2.3.2 Criticisms of the Mainstream Theories of the Demand for Money

Critics say that all mainstream theories on the demand for money are based on common assumptions that the markets for goods and finance are well developed. So, deviations from full employment is a result of short run frictions such as price or wage rigidity, and mainly emanating from demand side of the equation. The reality however is that in least developed countries, the labour and financial markets are underdeveloped and the goods market is less organized [see Agenor and Monteil, 1999]. So, during the period of rapid growth, the consequent structural transformation is expected to affect the organization of the labour and financial markets. The change in the organization of markets would be reflected in the expansion of banking services, introduction of new financial instruments, and integration of the less-monetized sectors into the monetized ones. However, if governments of LDCs fail to recognize the reality on the ground and hence fail to take the necessary policy actions that could match the implications of the process of structural transformation on the structure of production and trade, monetary policy could be less optimal and, consequently, economic growth could be impaired.[33]

Ignoring the effect of monetization implies that: one, in the long run, monetary policy could potentially underestimate the extent of the demand for money, and the economy could be underprovided with long-term liquidity, which could potentially be translated into real assets. Second, the economy would also miss the opportunity to speed up the process and create favourable conditions to enhance domestic savings. Mishra et al (2010) argue that weak institutional frameworks and a reduced role of securities markets weakens the effectiveness of traditional channels of monetary policy such as the interest rate, bank lending, and asset price in low income countries.

As discussed in the previous paragraph, during structural transformation, governments would get the opportunity to speed up the monetization process through such policy actions as creating favourable conditions for increased access to finance and introducing new financial instruments (to encourage financial savings). Reluctance by policy makers to recognize the effect of monetization costs those countries which

[33]Khan (1980, p.37) argues that "Monetization of the economy is continuously expanding in developing countries. It should therefore be an important determinant of growth in the demand for money over time.

aspire to achieve sustainably high economic growth as they miss the opportunity to deploy an optimal monetary policy that could further enhance growth and help sustain macroeconomic stability[34][McLoughlin and Noriaki, 2012].

The other criticism is that the mainstream monetary theories place much emphasis on the utility side of money, which limits modellers from considering other potential determinants of the demand for money [Banafea, 2012]. Recent empirical research has identified at least three more important determinants of the demand for money – the exchange rate, the inflation rate and the foreign interest rate [Bahmani-Oskooee and Malixi, 1991 and Banafea, 2012]. For instance, Laidler (1985, p.118) argues "for open economies such as Britain and Canada, foreign interest rates appear to be relevant measures of the opportunity cost of holding money". Second, the exchange rate (and expectation about it) is found to be one of the most important determinants of the demand for money function in developing countries. Bahmani-Oskooee and Malixi (1991) argue that as many of developing countries pegged their currencies to one or a basket of major international currencies, their currencies fluctuate along with the major currencies as long as major currencies fluctuate against one another[35]. Third, expected inflation rate is also found to be a significant determinant of the demand for money particularly in countries with history of high inflation [Laidler, 1985 and Bahmani-Oskooee and Malixi, 1991]. Recently, a number of studies including Bahmani-Oskooee and Rehman (2005), Narayan, et al (2009), Arize, et al (1999) and Abdullah, et al (2010) specify the demand for money equation based on non-conventional theory that focuses on the services of money as shown in equation (2.4).

$$M = f(y, r_d, r_f, e, \Pi)P \quad \ldots\ldots 2.4$$

where M, P and y are as defined in equation 2.1; r_d is domestic rate of interest, r_f is foreign rate of interest, e is the exchange rate and Π is the expected inflation rate. The

[34] Wrong monetary policy would ultimately cost long term economic growth and macroeconomic stability. Similar to the 1970s in advanced countries, structural transformation might have started to affect the stability of demand for money in African economies. Nonetheless, there are no studies in these countries particular on the determinants of the demand for money in the context of rapid structural transformation and monetization.

[35] "The relationship between exchange rate and money demand was originally conjectured by Mundell (1963, p.484) who wrote 'The demand for money is likely to depend upon the exchange rate in addition to the interest rate and the level of income.' There are two major implications of this link, first, as discussed by Mundell (1963), if demand for money depends on the exchange rate, effectiveness of monetary policy could be reduced and that of fiscal policy could be increased" [Bahmani-Oskooee and Malixi, 1991 p.1378].

relationship between the exchange rate and real money demand is indeterminate[36]. It could be negative or positive depending on how strong the forces of currency substitution are over the real balance adjustment[37]. For instance, when individuals perceive that the rate of depreciation is mild and it is intended to correct differences between domestic and foreign inflation, the demand for money could increase despite depreciation of the currency. On the other hand, when individuals perceive that the rate of currency depreciation is high and unpredictable, then they may prefer to hedge the value of their wealth by shifting to foreign currencies. In the latter case, the demand for money and exchange rate would have negative relationship. The coefficient of the foreign interest rate (Rf) variable is expected to have a positive sign implying that an increase in foreign interest rate decreases the opportunity cost of holding money. On the other hand, the inflation rate (Π) is expected to have a negative sign. During high inflation, agents quickly move away from holding money and prefer to buy durable goods as a hedge to inflation.

2.4 The Theoretical Framework of the Augmented Model

In section 2.3.2, we have seen that the major criticism of conventional theories and non-conventional models is that they take markets as given. Individuals' demand for money is determined either by a scale variable, which represents the transaction demand for money, or by the opportunity cost variables, which represent individuals' willingness to sacrifice returns from holding other financial or real assets to hold money. Hence, it is possible to summarize these models by the following functional relationship.

$$M/P = F(S, OC) \quad \ldots\ldots 2.5$$

where M/P is the demand for real balances, S is the chosen scale variables (which is usually represented by current income (Y) or permanent income (Y^P) in the literature, and OC is a set of opportunity costs of money such as the interest rate, inflation, the

[36]However, based on their empirical studies on 13 developing countries, over the period 1973I-1985IV, Bahmani-Oskooee and Malixi (1991, p.1383) argue that "whereas short-run effects of a depreciation could be in either direction, its long-run effect are negative in most cases indicating that in most LDCs, depreciation causes a decrease in the demand for domestic currency".

[37]It is to be noted that the exchange rate is defined as domestic currency per unit of foreign currency.

exchange rate. This approach fails to take into account the dynamics of monetary development in least developed countries during a rapid transition from a state of less monetized to more monetized economy. During a transition period, new individuals join the monetized economy on continuous basis and the demand for money is expected to see rapid increases.

The existing scale variables, such as in equation 2.5, do not capture the dynamics in its entirety for two reasons. One, the scale variable is usually proxied by such macro or aggregate variables as measured income or permanent income, which fails to capture the change in the structure of the economy between sectors. The argument is that as per-capita income of the rural people increases, people want to spend money on new goods and services that improve the quality of their lives. In the rural areas, the improvement in the quality of life is mostly reflected in increased use of hired labour instead of own labour, use of modern transportation system instead of horsebacks, use of modern communication systems and electric power, and a tendency to include a variety of manufactured goods in their consumption baskets. For instance, public investment in new road, telecom and electric power networks has made the services of these activities easily available to people, in the rural area, who can afford to pay. As these goods and services are new, which were not parts of their consumption baskets, it implies an increase in demand for money, for a given income (in the rural area). Hence, in this particular case, the decision to hold money is determined not by the level of the scale variable or the opportunity cost of money, but by the extent of transformation in the quality of life of this group of people. Therefore, in the absence of a demand for money function that could capture the effects of the structural transformation process, the magnitude of the demand for money tends to be underestimated in LDCs. Two, when countries are in a rapid economic growth dynamics, the process of structural transformation is so rapid that the model might be subjected to structural breaks, and, therefore, the demand for money function turns out to be unstable.

To this end, I have introduced a new variable that is meant to capture the structural transformation information in LDCs into the demand for money function. This variable is expected to capture the effect of a rapid shift in the importance of the less-monetized sector (rural sector) in the determination of demand for money[38]. Equation 2.6 below is

[38] The rural sector used to have marginal effect on the demand for money.

the proposed augmented money demand function that incorporates the structural transformation information variable.

$$M/P = F(S, ST, OC) \quad \ldots\ldots 2.6$$

where M/P, S, and OC are as defined in equation 2.5; and ST is a proxy to capture the effects of the structural transformation process in LDCs.

2.5 The Link between Structural Transformation and the Demand for Money

Since the 1990s, particularly in the last ten years, many African counties have been undergoing a rapid structural transformation: average rate of economic growth between 2000 and 2011 exceeded 6 percent in the nine African countries[39]. Moreover, the share of agriculture in GDP dropped significantly; urbanization has speeded up; and a significant part of the rural population has integrated into the modern way of life. Investments in infrastructure (including telecom, power and transport), education and health accelerated the integration process.

Structural transformation affects the demand for money in three ways. One: the urbanization impact and shrinking of the information gap between the urban and rural people. First, urbanization process leads to a continuous decline in the share of national output which is produced by family labour (in subsistence agriculture), and replaces it with a monetized production system.[40] Laidler (1985, p.47) argues that "the proportion of income actually involved in market transaction can change over time as economic units become more and more specialized and hence interdependent, producing less and less for their own consumption and more and more for the market." Second, having easy access to telephone, particularly mobile telephone, and road transport services have revolutionized the marketing strategies of the rural people. For instance, since the expansion of the mobile telephone services into rural areas, farmers in Ethiopia have begun to access up-to-date information about market prices of their main products. As a

[39] The nine countries include Ethiopia, Ghana, Kenya, Malawi, Nigeria, Rwanda, Tanzania, Uganda, and Zambia.

[40] Rapid economic growth intensifies the influx of rural labour to the cities attracted by wage (income) differences with the increase in the demand for unskilled labour in the construction sector, housemaids, manufacturing and services sectors (Lall, et al, 2006).

result, they have changed their marketing strategies substantially, particularly in terms of the timing of selling of their produces. Hence, in the domestic market, relative prices have increasingly shifted in favour of agricultural products[41]. Two: the increase in the per-capita income of the rural people and better access to public infrastructure services[42]. With the increase in per capita income, rural families begin to afford paying for hired labour, transport, telephone bills, health, and education. The number of rural families who use hired labour during harvest and/or sow seasons is increasing. Also, the number of people who use mobile telephones is growing fast in rural Africa.

Third: an increase in the importance of financial institutions in rural families. As the importance of money for everyday transactions increases, the number of rural people who have savings accounts in the formal financial institution and rural microfinance institutions grows. For instance, in Ethiopia, the strategy to enhance access to finance to the rural population, particularly through expansion of microfinance services, has encouraged farmers to monetize their produces and deposit the surplus proceeds in monetary terms in formal financial institutions such as banks and MFIs. Moreover, the expansion of financial institutions has created the opportunity to access loans from formal financial institutions. This has substantially changed the household financing strategy of most farmers, particularly by monetizing future produce during slack seasons. For instance, in Ethiopia, about 2.4 million individuals in rural areas were customers of MFIs and were confirmed to have savings accounts in the same in 2013 (Borga, 2013). In Kenya, mobile banking is widely used to transfer money and pay bills in rural areas (Mbiti and Weil, 2011). These are all reflected in a rapid monetization process. Consequently, the rates of growth of the demand for money have been faster than the rates of growth of nominal GDP in most fast growing economies in Africa. For instance, average M2/GDP ratio jumped from 18.2 percent in 1990 to 32.2 percent in 2013 in the nine fast growing economies in Africa. Among the latter, the fastest increases in the ratio were registered in Ghana, Kenya and Uganda, in which the ratio jumped from 6.8 percent, 24.5 percent and 8.4 percent to 32.7 percent, 55.8 percent and 24 percent, respectively.

[41] For instance, starting 2006, seasonality of agricultural prices has disappeared.

[42] Expansion of road, electricity, telecommunication, health, and education infrastructure in semi-urban towns and rural areas integrated a significant portion of the rural families into the modern sector, which uses money in its everyday life.

Getting a proxy for Impact of Structural Transformation

Getting a good proxy for the impact of structural transformation (ST) that fits into the demand for money function is a challenge. The proxy should fulfil at least two criteria. One, it must be a variable that captures the change in the structure of the less modern part of an economy, relative to the modern one, i.e., transformation of part of an economy from less monetized state to a more monetized one. Two, the variable must be measurable and predictable so that it could have policy relevance.

There are at least three candidates: one, the number of bank branches and microfinance branches operating in rural and small urban towns or the number of saving accounts by rural families; two, the ratio of agricultural GDP to non-agricultural GDP; and three, per-capita agricultural income (GDP). The number of bank and microfinance branches in rural and small urban towns could be a good proxy for monetization process because these are the institution that intermediate finance in the rural areas. People deposit their money, make payments, receive or transfer money through these institutions. The limitations, however, are that: first, getting a time series data for bank branches, disaggregated by rural and urban areas is difficult. For most African countries, the data for total bank branches, which is not even disaggregated, is available for less than ten years (see WDI database). Second, bank branch expansion could endogenously be determined by the demand for money itself.

The second potential proxy is the ratio of agricultural GDP-to-non-agricultural GDP. This indicator is expected to capture the growth in rural income relative to urban income. The rise in rural income relative to urban income potentially indicates the rise in productivity in rural activities and/or increase in the demand for agricultural produces more than non-agricultural ones. This implies rural lives are getting better and the rural people can afford to save and pay for transactions such as transport services, telephone, electricity, private schooling and also can afford to consume more and more manufactured goods such as clothing and processed food items. Moreover, a long time series data is available at the UN statistical and the World Bank WDI databases. One of the limitations of this indicator, however is, that since the numerator and the denominator are subject to different sets of shocks in different countries, it is difficult to identify whether the ratio has changed due to differences in relative sectoral growth

rates (a structural transformation process) or due to exogenous shocks such as drought and international price shocks. For instance, the effect of drought is more severe in agriculture than in industry or services.

The third potential proxy is per-capita rural income. Rural per capita income measures how rapidly average income of the rural people evolves over time during the structural transformation process. This is a better proxy than the agriculture-to-non-agriculture GDP for the following reasons. One, since the chapter is interested to model the impact of the structural transformation process on the demand for money, rural per-capita income carries such information that indicate the transformation of peoples' life styles from a backward to a modern one, i.e., the transition process from being a subsistence to self-sufficient and then to becoming a surplus economic agent. The latter affects the demand for money in the process as new items begin to be incorporated in the rural people's consumption baskets. For instance, when rural income is at a subsistence level, the role of money is limited because there is less hired labour, less integration to the modern way of life, and also limited use of cash to pay for services such as telephone bills, electricity bills and transport fees, if these services exist at all. On the other hand, when rural people's income increases, and people graduates to self-sufficient and then to becoming a surplus economic agent, the demand for money is expected to exhibit continuous upward shifts, for a given income. This is because the demand for money to acquire new items in their consumption baskets, such as to buy manufactured (processed) goods, to pay taxes, to pay transport fees, to pay telephone bills and to pay for labour services, continues to grow.

Two, the shocks to agricultural income are almost similar in most countries in Africa compared to the shocks to the non-agriculture sectors' income. The most common shock to agriculture in Sub-Sahara African counties is drought. In addition, international price shocks have similar effects in Sub-Sahara African countries, as most producers are price takers in the world market. Hence, for this chapter, rural per capita income is used as a proxy variable, and the newly proposed augmented non-conventional demand for money function with a structural transformation information variable, takes the following form:

$M= f(y, ST, r_d, e, \Pi)P$ …….……..……..…….. 2.7

where ‘ST’ is structural transformation information (monetization) variable, which is proxied by real per-capita rural income. The other variables are as defined in equation 2.4 above.

2.6 Data Description and Analysis

2.6.1 Description of Data

For the empirical estimation, the panel incorporates nine African countries, which are selected based on the following four criteria. One, the country must have registered at least 5 percent annual average economic growth in the recent 10 years (between 2002 and 2011). Second, the country must not be a member of a monetary union, and the monetary authorities are solely responsible to any monetary decision in the country. Third, the country has been categorized as a less developed country, by the United Nations, at one stage in the last 30 years, i.e., during the sample period. Finally, yet importantly, is the availability of sufficient data for a balanced panel data analysis. Accordingly, the following nine countries are included in the panel: Ethiopia, Ghana, Kenya, Malawi, Nigeria, Rwanda, Tanzania, Uganda, and Zambia.

The panel data covers the period between 1980 and 2011. Annex 2.1 presents the definitions and sources of date used for empirical analysis. For instance, data on real gross domestic product (Y) (and its components) and the GDP deflator (DEF) are obtained from United Nations National Accounts Database. On the other hand, narrow money supply (M1), broad money supply (M2), and the consumer price index (P) data are obtained from the World Bank World Development Indicators (WDI). The chapter also uses the United Nations National Accounts Database to compute real per capita rural output (ROUT). ROUT is computed as a ratio of real agricultural output (Yag) to rural population (RURPOP). On the other hand, the International Financial Statistics (IFS) database is used to obtain the real effective exchange rate (REER) and the domestic interest rate (r) data series.

2.6.2 The Choice between Permanent and Measured Income

One of the controversial issues in the specification of the demand for money is whether it is plausible to use permanent income or measured income as a scale variable. Hence, before proceeding to the different procedures of panel co-integration analysis, the chapter finds it appropriate to settle this question first.

Permanent income (Y^P) series is derived using the following adaptive expectation type model employed by Harris (1985) and Laidler (1985).

$$Y^P = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \beta_3 Y_{t-3} + \beta_4 Y_{t-4} + \beta_5 Y_{t-5} + \beta_0 t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.8$$

where per capita real GDP is used as a proxy to real per capita income (Y) and and 't' is time. β_0 and β_i are constant and slope coefficients, respectively. The subscript 't-i' refers to the lag length. Estimation results of equation (2.8) is presented in Annex 2.3.

Table 2.1 shows that the income and interest-rate elasticities possess the expected signs and the coefficient of Ln(Y) and Ln(Y^P) are significantly different from zero. The estimation results also indicate that, in terms of magnitude and significance of the coefficients, there are no major differences between the permanent income and measured income elasticities in both narrowly and broadly defined demand for money models. Such a result is expected in least developed countries because personal savings are very low and consumption is mainly constrained by current income flows. Therefore, the rest of the chapter will proceed to use income (Y) as a scale variable.

Table 2-1: Estimation Results of the Long run equation of the Conventional Model

	Dependent Variable: $Ln(M1/P)_{it}$				Dependent Variable: $Ln(M2/P)_{it}$			
	Measured income (Y)		Permanent Income (Y^P)		Measured income (Y)		Permanent Income (Y^P)	
$Ln(Y)_{it}$	1.315	21.7***	1.322	22.5***	1.369	25.6***	1.399	26.3***
r_{it}	-1.238	-4.241***	-1.286	-4.502***	-0.985	-3.388***	-1.019	-3.640***
Ln(REER)it	-0.194	-3.845***	-0.210	-4.336***	-0.279	-6.168***	-0.282	-6.611***
c_i	-3.921	-2.466**	-3.992	-2.591***	-4.248	-3.024***	-4.933	-3.555***
Obs.	269		269		274		274	
R^2	0.983		0.985		0.985		0.987	

* significant at 10 percent level

** significant at 5 percent level

*** significant at 1 percent level

2.7 Structure of the ARDL Models and Estimation Results

Having settled the choice of the scale variable between permanent and current income, the next step, before proceeding to conduct a cointegration analysis, is to confirm the time series properties of the variables. As depicted in Annex 2.2, the unit root tests show that all the variables in the model, except the inflation rate (Infl), are found to be non-stationary in levels while, on the other hand, they are all found to be stationary in first differences.

2.7.1 The Economic Estimation Procedure

The presence of a stationary series in the non-conventional models prevents the use of a residual based cointegraion technique. Therefore, for the empirical estimation, I will use an autoregressive distributed lag (ARDL) approach, which is proposed by Pesaran et al (2001) for a long-run cointegration model in a situation where there are one or more stationary variables in the model. A study by Gerrard and Godfrey (1998, p.235) finds that the ARDL approach provides not only better estimators of the long-run coefficients but also more reliable diagnostic procedures for the derived ECM than the Engle-Granger variant. They also argue that although both Engle-Granger and ADL methods yield super-consistent estimators of long-run coefficients, because of small sample biases, the LM test for autocorrelation and the RESET test may be severely oversized when applied to the equation of the Engle-Granger variant.

The asymptotic theory that Pesaran et al, (2001, p.315) developed offers ‘a simple univariate framework for testing the existence of a single level relationship between the regressand and the regressors when it is not known with certainty whether the regressors are purely I(0) or purely I(1) or mutually cointegrated’. Therefore, following Peresan et al (2001), the theoretical demand for money models in equations (2.1), (2.2) and (2.6) are estimated one-by-one using a short-run dynamic error correction method, which is specified as a single equation autoregressive distributive lag (ARDL) format as follows:

$$\Delta Ln(Md/P)_{it} = \sum\alpha_{1j}\Delta(Md_k/P)_{ijt-z-1} + \sum\alpha_{2j}\Delta Y_{ijt-z} + \sum\alpha_{3j}\Delta Ln(PC\_RUROUT)_{ijt-z} + \sum\alpha_{4j}\Delta r_{ijt-z} +$$
$$\sum\alpha_{5j}LnREER_{ijt-z} + \sum\alpha_{6j}Inf_{ijt-z} + \alpha_7[Ln(Md_k/P)_{it-1} + \beta_0 + \beta_1 LnYi_{t-1} +$$
$$\beta_2 Ln(PC\_RUROUT)_{it-1} + \beta_3 r_{it-1} + \beta_4 LnREER_{it-1} + \beta_5 Infl_{it-1}] + u_{it} \quad \text{..... 2.9}$$

where Md is nominal money demand; k is level of aggregation of money supply (either M1 or M2); P is the consumer price index; Y is a scale variable representing real GDP at market price; PC_RUROUT is real per capital rural output which is derived by dividing real agricultural output by rural population; and r is the nominal interest rate representing the opportunity cost of holding money. Since the bond or equity markets are underdeveloped or non-existent at all in countries in the panel, the nominal short-term interest rates such as central bank discount rates or short-term deposit rates are used. u is the error term which is assumed to be identically and independently distributed with mean zero and variance σ^2, i.e., iid(0, σ^2). REER is real effective exchange rate. The use of REER, instead of bilateral nominal exchange rate, in the demand for money function, was first forwarded by Bahmani-Oskooee and Malixi (1991). The subscript 'i' refers to country and j = 1 … n stands for explanatory variables included in the equation and z = 0…. Z counts over time-periods, with Z equal to the maximum lag. $\alpha_{1j} - \alpha_{6j}$ are the short-run coefficients, and β_j are the long-run coefficients. α_7 is the speed of adjustment or the error correction term and the expression in bracket represents the long-run vector.

The null hypothesis, in equation (2.9), is defined as H_0: $\alpha_7 = 0$, that is no level relationship or no cointegration, and is tested against the alternative that H_0: $\alpha_7 \neq 0$, using an F-test. Pesaran et al's (2001) bound testing approach provides lower bound and upper bound critical values for the F-statistics. The lower bound assumes that all variables are I(0) and the upper bound that all variables are I(1). Accordingly, testing the error correction term, α_7, against the critical values using a F-statistic tabulated in Pesaran et al, (2001) provides the answer as to whether there is a long-run relationship or not. If the calculated t-statistic lies above the upper bound, the null will be rejected, and confirm the presence of the long-run cointegrating vector in the model [Bahmani-Oskooee and Rehman, 2005].

In the long-run vector, the slopes of real income (β_1) and rural per capita income (β_2) are expected to be positive while the slopes of the nominal interest rate (β_3) and

inflation expectation variable (β_5) are expected to be negative. On the other hand, the sign of the REER coefficient is indeterminate. It could be positive or negative depending on the extent of public confidence on monetary policy regime and the strength of the domestic currency in the respective countries. If the public is confident about the intention and effectiveness of monetary policy and feel that the current depreciation is part of an adjustment process to the long-run equilibrium, the demand for domestic currency increases following a depreciation of the currency. This implies that the transaction demand effect outweighs the currency substitution effect in that country. On the other hand, if people expect that deprecation of the currency is a move away from the long-run equilibrium and continues to lose confidence of the effectiveness of monetary policy, depreciation of the currency is expected to lead to a decline in the demand for money. Except the nominal interest rate and inflation rate variables, all the other variables in the model are transformed into logs. The interest rate and inflation rate are expressed in percentage forms.

On the other hand, one of the drawbacks of estimating single-equation ECMs is that the approach is built on the assumption that all explanatory variables are weakly exogenous. Particularly, since the model uses annual data, it is reasonable to suspect contemporaneous correlations. Banerjee (1998, p.274) states that the weak exogeneity assumption is fairly well used in practice and allows for the presence of lags of the dependent and explanatory variables in the data generation process of the ARDL conditional model. Durevall, et al (2013) argues that if the estimated coefficients are confirmed to be stable, we can use this fact as an indirect support for the use of single-equation ECMs.

Equation (2.9) is estimated using panel cross section fixed effect model, with GLS weights assuming that the initial conditions in each country in the panel differs. To find the parsimonious model with the appropriate lag length, I rely on the Akaike Information Criteria (AIC). In addition, due to the absence of a sufficiently long data series, the maximum lag length is pre-determined. The lag length is set at 3 as the money demand equations are expected to have relatively quick convergence to equilibrium and have relatively large number of explanatory variables.

Equation 2.9 is a nested model, which encompasses both the conventional model (equation 2.1) and the non-conventional model (equation 2.2).

1/ If $\beta_3 = \beta_4 = \beta_5 = 0$, equation (2.9) turns into the conventional money demand model (equation 2.1)

2/ If $\beta_3 = 0$, equation 2.9 turns into the augmented non-conventional money demand model (equation 2.2).

2.7.2 Panel Co-integration Results

2.7.2.1 The Augmented Non-conventional Model

Table 2.2 presents the estimated coefficients and their respective estimated t-ratios of the short-run variables (α_{ij}) and long-run cointegrating vector variables (β_j) of equation 2.9. The table depicts that the error correction terms of both the narrowly defined demand for money model ($Ln(Md_1/P)_{it}$ and broadly defined demand for money models ($Ln(Md_2/P)_{it}$ are significant at 1 percent level and the overall fit of the models, as measured by the adjusted R^2, are between 0.44 and 0.52. Moreover, all the explanatory variables of the long-run part of the model, including the structural transformation information variable – PC_RUROUT - are found significant at 1 percent, and all the variables are found to have the expected signs. The speed of adjustment coefficient indicates that about half the deviation from long-run equilibrium would be corrected within one year in the case of broadly defined money demand.

Table 2.3 presents the normalized coefficients of the long-run money demand vector. The normalized coefficients of the explanatory variables are derived dividing the estimated coefficients of the respective long-term explanatory variables in the co-integration vector by the coefficient of the error correction term in Table 2.2. The table shows that the coefficient of the structural transformation variable (PC_RUROUT) is estimated to be 0.30 in the case of the narrowly defined demand for money model and 0.43 in the case of the broadly defined model. This implies that a one percent increase in per capital income of the rural population is expected to produce a 0.3 percent increase in the demand for narrow money while, in the case of broad money, it is expected to generate a 0.43 percent increase in the demand for money. This confirms the argument of the chapter that structural transformation is one of the important determinants of the

Table 2-2: Short Run Dynamic Cointegration Estimation Results of the Augmented Non-Conventional Model

	With Structural Transformation Information			
	$\Delta Ln(M1/P)_{it}$		$\Delta Ln(M2/P)_{it}$	
	Coeff.	t-ratios	Coeff.	t-ratios
Short run dynamics				
$\Delta Ln(Md_j/P)_{it-1}$	0.210	(2.166)**	0.198	(2.098)**
$\Delta Ln(Md_j/P)_{it-2}$	0.052	(0.528)	0.079	(0.816)
$\Delta Ln(Md_j/P)_{it-2}$	0.047	(0.483)	0.060	(0.647)
ΔLnY_{it}	0.306	(1.280)	0.407	(1.951)*
ΔLnY_{it-1}	-0.274	(-1.042)	-0.360	(-1.584)
ΔLnY_{it-2}	-0.465	(-1.776)*	-0.156	(-0.695)
ΔLnY_{it-3}	0.419	(1.541)	0.025	(0.109)
$\Delta LnPC\_RUROUT_{it}$	-0.168	(-1.418)	-0.118	(-1.095)
$\Delta LnPC\_RUROUT_{it-1}$	-0.273	(-1.973)**	-0.221	(-1.795)*
$\Delta LnPC\_RUROUT_{it-2}$	0.041	(0.298)	-0.073	(-0.604)
$\Delta LnPC\_RUROUT_{it-3}$	-0.107	(-0.826)	-0.017	(-0.153)
ΔR_{it}	-0.208	(-0.804)	-0.078	(-0.496)
ΔR_{it-1}	0.557	(1.962)**	0.500	(2.620)***
ΔR_{it-2}	0.419	(1.621)	0.413	(2.400)**
ΔR_{it-3}	0.066	(0.282)	0.142	(0.934)
$\Delta LnREER_{it}$	-0.146	(-1.673)*	-0.233	(-3.478)***
$\Delta LnREER_{it-1}$	-0.003	(-0.041)	0.055	(1.022)
$\Delta LnREER_{it-2}$	0.024	(0.380)	0.085	(1.854)*
$\Delta LnREER_{it-3}$	0.024	(0.372)	0.030	(0.685)
$\Delta INFL_{it}$	-0.471	(-5.790)***	-0.439	(-6.598)***
$\Delta INFL_{it-1}$	0.155	(1.645)*	0.191	(2.248)**
$\Delta INFL_{it-2}$	0.122	(1.404)	0.152	(1.974)**
$\Delta INFL_{it-3}$	0.092	(1.197)	0.107	(1.669)*
Conintergation Vector				
$Ln(Md/P)_{it-1}$	-0.454	(-7.766)***	-0.510	(-8.426)***
LnY_{it-1}	0.470	(5.983)***	0.542	(7.276)***
$LnPC\_RUROUT_{it-1}$	0.137	(1.667)*	0.221	(3.098)***
r_{it-1}	-0.928	(-3.027)***	-0.797	(-3.680)***
$LnREER_{it-1}$	-0.191	(-3.875)***	-0.273	(-6.368)***
$Infl_{it-1}$	-0.389	(-4.917)***	-0.467	(-6.698)***
C_i	1.152	(0.851)	1.105	(1.089)
$\mathbf{R^2}$	0.538		0.605	
Adj.R2	0.435		0.519	
Obs.	204		209	

demand for money models in fast growing African countries. It implies that, assuming all the other variables in the model remain unchanged, on average, countries in the panel need to increase the broadly defined money supply by 0.43 percent for a one percent increase in real per capita income of the rural population to keep the money market in equilibrium.

Table 2-3: The Long-run Coefficients of the Augmented Non-Conventional Model

	Narrow Money (M1)	Broad Money (M2)
Ln(M1/P)	1.000	
Ln(M2/P)		1.000
LnY	1.035***	1.063***
LnPC_RUROUT	0.302***	0.433***
LnREER	-0.421*	-0.535***
r	-2.044***	-1.563***
Infl	-0.857***	-0.916***
C	1.152	2.167
Speed of Adjustment	-0.454***	-0.510***

* significant at 10 percent level
** significant at 5 percent level
*** significant at 1 percent level

In line with the theory, the magnitudes of the income elasticities of demand for money are found to be near unitary, i.e., 1.03 in the case of the narrowly defined money demand model and 1.06 in the broadly defined one. The interest rate is also found to have the expected sign with a one percent level of significance. Accordingly, a one-percentage point increase in nominal interest rate is expected to lead to a 2 percent decline in money demand in the case of the M1 model, while a percentage point increase in interest rate is expected to decrease the demand for broadly defined real balance by 1.6 percent, in the broadly defined money demand (M2) model.

In general, the broadly defined model seems to perform better than the narrowly defined one. For instance, the magnitude of the speed of adjustment to the long-run equilibrium increases significantly, from -0.45 in the M1 model to -0.51 in the M2 model. Moreover, the overall fit of the models, again as measured by adjusted R^2, improves from 0.44 to 0.52. This indicates that M2 is correlated with economic activities better than M1, in most of the African countries in the panel.

2.7.2.2 Comparison of the Three Models - The Conventional, Non-Conventional and Augmented Non-Conventional Models

Table 2.4 presents estimation results of the three models, i.e., the augmented non-conventional, non-conventional and conventional models. The results confirm that, in general, the non-conventional models perform far better than the conventional model in terms of overall fit, the expected signs, significance level of the coefficients and the magnitude of the coefficients of the explanatory variables in the long-run part of the model when compared with the theoretical motivations. For instance, in the broadly defined money demand (M2) model, the overall fit of the model, as measured by adjusted R^2, improves significantly from 0.16 in the conventional model to 0.50 in the non-conventional model and 0.52 in the augmented non-conventional model. With respect to the real income, which is the scale variable, the elasticity coefficient is found to be significant at one percent level in all the models. However, the magnitude of the coefficient is estimated to be 1.8 in the case of the conventional model while it turns out to be close to unitary in both the non-conventional and augmented non-conventional models in line with the theoretical arguments. Interest rate is found to be insignificant in the conventional model while all the variables (including the interest rate) are found significant in the non-conventional models (with the expected signs).

On the other hand, a comparison between the two non-conventional models confirms that the augmented model, which has the structural information variable, performs better in many respects, including the magnitude of the speed of adjustment and overall fit of the model. For instance, in the M2 model, the speed of adjustment to the long-run equilibrium increases

Table 2-4: Estimation Results of ARDL Based Short Run Dynamic Cointegration Models

	Conventional Model				Non-Conventional Model				Augmented Non-Conventional Model			
	ΔLn(M1/P)it		ΔLn(M2/P)it		ΔLn(M1/P)it		ΔLn(M2/P)it		ΔLn(M1/P)it		ΔLn(M2/P)it	
$\Delta Ln(Md_t/P)_{it-1}$	0.192	(2.469)**	0.208	(2.851)***	0.195	(2.053)**	0.222	(2.261)**	0.210	(2.166)**	0.198	(2.098)**
$\Delta Ln(Md_t/P)_{it-2}$	-0.058	(-0.747)	-0.021	(-0.280)	0.056	(0.578)	0.081	(0.804)	0.052	(0.528)	0.079	(0.816)
$\Delta Ln(Md_t/P)_{it-2}$	0.011	(0.144)	-0.002	(-0.022)	0.044	(0.459)	0.062	(0.643)	0.047	(0.483)	0.060	(0.647)
ΔLnY_{it}	0.324	(1.826)*	0.403	(2.517)**	0.137	(0.784)	0.273	(1.903)*	0.306	(1.280)	0.407	(1.951)*
ΔLnY_{it-1}	-0.202	(-1.025)	-0.139	(-0.765)	-0.417	(-2.208)**	-0.330	(-2.115)**	-0.274	(-1.042)	-0.360	(-1.584)
ΔLnY_{it-2}	-0.275	(-1.477)	-0.025	(-0.147)	-0.193	(-1.047)	0.015	(0.101)	-0.465	(-1.776)*	-0.156	(-0.695)
ΔLnY_{it-3}	0.299	(1.695)*	0.137	(0.838)	0.341	(1.810)*	0.131	(0.849)	0.419	(1.541)	0.025	(0.109)
$\Delta LnPC\_ROUT_{it}$									-0.168	(-1.418)	-0.118	(-1.095)
$\Delta LnPC\_ROUT_{it-1}$									-0.273	(-1.973)**	-0.221	(-1.795)*
$\Delta LnPC\_ROUT_{it-2}$									0.041	(0.298)	-0.073	(-0.604)
$\Delta LnPC\_ROUT_{it-3}$									-0.107	(-0.826)	-0.017	(-0.153)
ΔR_{it}	-0.168	(-0.760)	0.019	(0.133)	-0.109	(-0.425)	-0.005	(-0.032)	-0.208	(-0.804)	-0.078	(-0.496)
ΔR_{it-1}	-0.050	(-0.216)	-0.133	(-0.814)	0.528	(1.871)*	0.419	(2.223)**	0.557	(1.962)**	0.500	(2.620)***
ΔR_{it-2}	-0.070	(-0.313)	-0.106	(-0.684)	0.397	(1.518)	0.325	(1.884)*	0.419	(1.621)	0.413	(2.400)**
ΔR_{it-3}	-0.342	(-1.618)*	-0.328	(-2.347)**	0.001	(0.006)	0.055	(0.359)	0.066	(0.282)	0.142	(0.934)
ΔLnREERit					-0.134	(-1.709)*	-0.201	(-3.439)***	-0.146	(-1.673)*	-0.233	(-3.478)***
ΔLnREERit-1					0.025	(0.365)	0.059	(1.195)	-0.003	(-0.041)	0.055	(1.022)
ΔLnREERit-2					0.039	(0.636)	0.108	(2.466)**	0.024	(0.380)	0.085	(1.854)*
ΔLnREERit-3					0.042	(0.660)	0.036	(0.861)	0.024	(0.372)	0.030	(0.685)
$\Delta INFL_{it}$					-0.463	(-6.040)***	-0.519	(-7.885)***	-0.471	(-5.790)***	-0.439	(-6.598)***
$\Delta INFL_{it-1}$					0.113	(1.224)	0.146	(1.628)	0.155	(1.645)*	0.191	(2.248)**
$\Delta INFL_{it-2}$					0.148	(1.699)*	0.118	(1.441)	0.122	(1.404)	0.152	(1.974)**
$\Delta INFL_{it-3}$					0.076	(1.008)	0.093	(1.424)	0.092	(1.197)	0.107	(1.669)*
Conintergation Vector												
$Ln(Md/P)_{it-1}$	-0.205	(-4.433)***	-0.161	(-4.247)***	-0.417	(-7.353)***	-0.429	(-7.426)***	-0.454	(-7.766)***	-0.510	(-8.426)***
LnY_{it-1}	0.320	(4.495)***	0.286	(4.129)***	0.433	(5.905)***	0.470	(6.661)***	0.470	(5.983)***	0.542	(7.276)***
$LnPC\_ROUT_{it-1}$									0.137	(1.667)*	0.221	(3.098)***
r_{it-1}	-0.165	(-0.707)	-0.039	(-0.235)	-0.810	(-2.682)***	-0.628	(-2.986)***	-0.928	(-3.027)***	-0.797	(-3.680)***
$LnREER_{it-1}$					-0.139	(-3.219)***	-0.201	(-5.268)***	-0.191	(-3.875)***	-0.273	(-6.368)***
$Infl_{it-1}$					-0.438	(-5.543)***	-0.494	(-6.368)***	-0.389	(-4.917)***	-0.467	(-6.698)***
Ci	-2.111	(-2.416)**	-2.372	(-2.842)***	1.565	(1.213)	1.508	(1.614)	1.152	(0.851)	1.105	(1.089)
R^2	0.233		0.241		0.504		0.575		0.538		0.605	
Adj.R2	0.144		0.156		0.411		0.497		0.435		0.519	
Obs.	213		218		204		209		204		209	

significantly, from -0.43 in the non-conventional model to -0.51 in the augmented non-conventional one. According to the augmented model, 51 percent of any deviation from the long-run equilibrium would be corrected within a year, while only about 43 percent of the deviation will be corrected within a year in the model without PC_RUROUT. Relying on the demand for money model that does not have the structural transformation variable has at least two major implications. First, the model converges to the long-run equilibrium path less quickly than the one with the structural transformation variable. This might lead to a policy action that over-shoots or under-shoots the demand for money depending on the initial position of the disequilibrium, and therefore, has a monetary policy cost, potentially leading to demonetization of the economy, particularly the rural sector. Second, without information about the magnitude of the impact, it is difficult for policy makers to determine or project ahead, the implication of the structural transformation process on the monetary policy. In other words, for policy makers, it is difficult to estimate how much additional demand for money is created in a given year as a result of the structural transformation of the economy, which will particularly be reflected in increased specialization of the rural population in production and trade. The latter enhances the role of money as a medium of exchange and as a store of value.

2.8 Summary and Recommendation

The chapter tries to provide theoretical arguments on how structural transformation process affects the stability of the demand for money. It also tries to empirically test the significance of the variable, and analyze the magnitude of the impact on the demand for money using the selected nine African countries in the panel. Estimation results confirm that monetization, measured by broad money-to-GDP ratio, is increasing fast in countries in the panel. Therefore, countries that ignore the contribution of structural transformation process on the demand for money would fall into a less optimal monetary policy regime. The latter, in turn, is expected to affect the rate of growth of the economy due to a less than optimal rate of domestic savings mobilization and lower state of factor productivities. For instance, when the economy is monetized below optimal level, it constrains the rate of growth of specialization and division of labour in the less monetized economy.

Consequently, labour productivity will be lower. Economies of the East Asian tigers such as South Korea, Malaysia, Singapore, Thailand and Taiwan were rapidly monetized during the periods of high economic growth, which were reflected in highest domestic saving-to-GDP ratios in the world.

There are at least two lessons that we can draw for the African countries from the results of the panel estimations. One, governments of African countries should give proper attention to the possible implications of the structural transformation process on their countries' demand for money functions, and consider them in their monetary policy frameworks [McLoughlin and Nariaki, 2012]. Two, it must be recognized that integration of the rural people to the modern production and trade system is unavoidable during the structural transformation process. Hence, as this has a positive and significant contribution to the growth of demand for money, developing countries should try to create favourable conditions for easy access to modern financial instruments by devising a financial inclusion strategy that pays proper attention to the rural people.

In terms of the performance of models, conventional models are found to be less fitted to the African countries' money markets. Although the long run vectors are found to be cointegrated in the conventional model, the speed of adjustment is less than 0.21 in absolute terms in the M2 model. Moreover, the conventional M2 model explains less than 16 percent of the demand for money, as measured by adjusted R^2. On the other hand, the non-conventional model is able to explain more about 50 percent of the variations of the demand for money. The speeds of adjustments are also far higher than those in the conventional models (about -0.5 in the M2 model).

Chapter 3

Evaluating Internal Consistency of Medium-Term Growth Strategies Using a Modified Financing Programming Model: The Case of Ethiopia

3.1 Introduction

This chapter provides an empirical analysis of the medium-term growth strategy in Ethiopia using a financial programming framework. Ethiopia has experienced a remarkably rapid and sustained growth in the past 10 years. What makes its economic growth experience even more interesting is that the economy has not only been growing rapidly but has done so without experiencing income inequality, which is one of the biggest challenges of rapid growth episodes. Few countries, mostly East Asian, have succeeded on the double criteria

of growth and equality [Todaro and Smith, 2009]. Between 2004[43] and 2013, real GDP grew at an annual average rate of growth of 10.9 percent, and yet, according to World Development Indicators (2015), the country managed to keep the GINI coefficient stable at around 0.3 for the last 15 years since 1999. Consequently, poverty incidence is reduced almost by half to 29 percent in 2011 from 56 percent in 2000 [UN, 2015].

Ethiopia experienced almost two decades of economic stagnation between 1975[44] and 1992. The economy was barely growing at an average rate of 0.9 percent during the period. The first episode of growth acceleration started in 1993 when the country launched an economic reform program with the help of the IMF and the World Bank. Between 1993 and 2002, three successive reform programs were implemented. As a result, average annual growth of real GDP jumped to 4.5 percent during period. Since 2004, economic growth accelerated even further and the growth trajectory has shifted up to a double-digit growth path. The government attributes the recent success to carefully designed growth plans and policies and its high commitment to eliminate extreme poverty. There were two development programs between 2003 and 2010. The first program, which was called the 'Three-year Sustainable Development and Poverty Reduction Program (SDPRP)' was launched in 2003. This was followed by a 'Five-year Poverty Reduction and Sustainable Development Program (PRSDP)', which was launched in 2006 [Federal Democratic Republic of Ethiopia, 2010 and IMF, 2011a and 2011b]. (Brief discussions of the programs are presented in section 3.3.3).

The successes of the first two development programs encouraged the Ethiopian government to launch a comprehensive development plan under the title of 'the First Five-Year Growth and Transformation Plan' (GTP I) in 2011 to cover the period 2011-15 [Federal Democratic Republic of Ethiopia, 2010 and IMF, 2011a, 2011b and 2011c]. The GTP envisages transformation of the economy from agriculture to a manufacturing base, and it is designed in line with the pressing objective of realizing the country's aspiration to

[43]All the years in this chapter refers to Ethiopian Fiscal Year. For instance, 2004 means 2003/04, i.e., July 7, 2003 to July 6, 2004.

[44]The year 1975 marks the fall of the imperial regime and takeover of power by the military junta, which was known as the Derg.

join the middle-income group the latest by the year 2025[45]. GTP I sets an annual average real GDP growth target at 11 percent while containing inflation within single digits and gross international reserves coverage of not less than 2 months of next year's imports of goods and services. Although the economy managed to register double-digits growth rates with reasonably moderate inflation rates in the previous seven years (2004-2010), the government has realized that sustaining these achievements for the next five more years could not be taken for granted, as the economy already more-than-doubled during the period, and the macroeconomic policy challenges have become more complex. Particularly, the low level of domestic savings and shallow export base are expected to pose major challenges as the success of the plan heavily relies on investment in infrastructure and manufacturing sectors that require huge financing both in local and foreign currencies. In 2010, a year before the launching of the plan, domestic savings as a ratio of GDP amounted to 9.5 percent that covered less than half of the gross domestic investment [Federal Democratic Republic of Ethiopia, 2010]. Similarly, foreign exchange earnings from exports were barely enough to cover 41.3 percent of imports. In the plan, domestic savings and exports of goods and services are targeted to reach 15 percent and 22.5 percent of GDP, respectively, by 2015.

To this end, the plan has laid out key macroeconomic and financial sector policy packages that give particular focus on domestic saving mobilization, export competitiveness and import substitution, curbing inflationary pressure, and maintaining the gross international reserves target. For instance, among the main macroeconomic policies: the exchange rate is set to be kept close to equilibrium; the real interest rate is targeted to be positive or near positive, with ± 2 percentage points from headline inflation rate; and total government deficit financing is set not to exceed 3 percent of GDP. Moreover, in the financial sector, new financial instruments such as saving bonds and additional contractual saving instruments such as private pension funds scheme are to be introduced, and policies

[45] The broad objectives of the GTP are to (i) attain high growth within a stable macroeconomic framework; (ii) achieve the MDGs in the social sector; and (iii) establish a stable democratic and developmental state. To accomplish these objectives, the GTP identifies the following strategic pillars: (i) sustain rapid growth; (ii) emphasize agriculture; (iii) promote industrialization; (iv) invest in infrastructure; (v) enhance social development; (vi) strengthen governance; and (vii) empower youth and women [International Monetary Fund, 2011 and Federal Democratic Republic of Ethiopia, 2010].

are devised to encourage banks and microfinance institutions expand their branches to reach out communities in small urban and rural areas, respectively[46].

Given the ambitious targets, the plan's success depends on how well it is made internally consistent to deliver the desired outcomes [Khan and Montiel, 1989 and Bruce, 1999], and whether it is possible to increase domestic savings by 5.5 percentage points of GDP within five years period. Detailed discussions on the experiences of East Asian countries in raising the domestic savings rate to finance investment and growth can be found in Kuijs (2005) and Jansen (2001) and He and Cao (2007). Moreover, as the experiences of China and other fast growing East Asian countries indicate, sustaining the current double-digits growth for the next fifteen more years, 2011- 2025, by the end of which the country aspires to join the middle-income countries club, requires a substantial improvement in total factor productivity (TFP), in addition to factor accumulation [Chen, 1997 and Wang and Yao, 2002]. World Bank (2009) finds that despite the substantial improvement in the business environment between 2002 and 2008, productivity remains very low in Ethiopia. Hence, the question is whether improving TFP is given due emphasis in the plan. Wang and Yao (2002), Chen (1997), Young (1995), Arbache, et al (2008) and Islam (2006) discuss the role that TFP played to East Asian countries' growth, including China in the last couple of decades.

The objectives of this chapter are therefore: first, to introduce a modified financial programming framework in the context of a developing economy that could simultaneously capture the major relationships between prices, the balance of payments and output. Second, using the modified framework, to analyze whether the announced plan targets in GTP I are achievable and the policy packages are internally consistent. The choice of a financial programming model over the traditional macroeconomic model is for the following reasons: First, unlike the traditional macro models, the financial programming framework, by design, works backwards from target to policies, following a standard planning approach, not the other way round. Bruce (1999, p.2) says that "a projection model asks 'what macroeconomic outcomes will result from a given set of policies?' while a programming model asks, 'what macroeconomic policies are required to achieve a given

[46]The plan has also laid out other detailed sectoral policies.

set of outcomes? 'The specified outcomes include targets for inflation and foreign exchange reserves, consistent with a commitment to macroeconomic stability." Hence, the FP framework is generally suitable for a planning exercise that assumes exogenously determined output and inflation targets[47]. Second, the FP framework allows applying a technique similar to the incremental capital output relationship (ICOR) to identify the amount of investment required for the growth target. Third, the FP mode is built on the framework that links the financial sector with the balance of payments. Therefore, it comprises a set of behavioral and accounting equations that allows for drawing up analyses and forecasts of economic growth that are consistent with the whole macroeconomic framework. This approach is commonly known as the monetary approach to the balance of payments, and it is designed to ensure consistency between the monetary impact of policy changes and the desired balance of payments outcome [Khan, et al, 1990 p.156]. Fourth, the Model is convenient to solve for equilibrium values of alternative sets of policy instruments such as exchange rate, interest rate and tax rate consistent with plan targets, making discussion on alternative policy packages easy for policy makers.

The modifications of the model that are introduced in this chapter focus on two major limitations that the traditional IMF financial programming model is being criticized for, particularly in the context of developing countries. Chapter 1 and chapter 2 of the thesis have dealt extensively with these limitations, and in view of addressing the shortcomings, alternative modeling frameworks are also proposed and estimated. The first limitation of the traditional financial programming model that this chapter zeros in on is its reliance on the neoclassical assumption of constant returns to scale production function with capital assumed to exhibit diminishing marginal returns [Romer, 2006, Agenor and Montiel, 1999 and Chen, 1997]. Second, the model also relies on the extreme assumption of constant income velocity of money based on the quantity theory of money [Reinhart, 1991].

Regarding the first limitation, the traditional FP framework assumes that long run growth is determined only by technological progress, which itself is determined exogenously outside the system. Therefore, long-term variables such as population growth and savings growth would have only level effects on per capita output. Moreover, the

[47]In traditional macro models, long-term output and prices are endogenously determined within the model.

model assumes that government policies such as investment in public goods do not have growth effects. The main reason for these rigidities is that the neo-classical production function is built on the basic assumptions of absence of distortions such as positive externalities, economies of scale and monetization of the economy [Chenery, 1986 and Romer, 2006]. In the neoclassical model, factor inputs other than labor and capital are relatively unimportant in the production function, and labor and capital are paid according to their respective marginal returns. As a result, there are no differences between the social returns and private returns of these factor inputs[48].

A number of literatures however argue that, in developing countries, where a significant share of the labor stock is engaged mainly in low-skilled production activities in agriculture and service sectors, there is a room for continuous improvement in labor productivity - for instance, through specialization, education and training [Romer, 2006, Agenor and Montiel, 1999, Chenery, 1986, and Feder, 1983]. They also argue that, government policies towards infrastructure development and export-led growth strategies generate positive externalities to the private sector by expanding the productive capacity of the economy, increasing the productivity of factor inputs - capital and labor, and creating economies of scale[49]. Labor and capital earn less than their respective marginal products in those sectors that generate positive externalities such that the private sector would under-invest in them. This implies that the equilibrium growth rate, in a competitive market framework without government policies (subsidies) such as investment in human capital and infrastructure output growth, would be smaller than the optimal growth rate[50]. In other words, per-capita output growth is endogenously determined. Therefore, in the modified framework, the production function is specified in line with an endogenous growth model that allows spillover effects

[48]Romer (2006, p. 10) explains, "The assumption of constant returns can be thought of as a combination of two separate assumptions. The first is that the economy is big enough that the gains from specialization have been exhausted. In a very small economy, there are probably enough possibilities for further specialization that doubling the amount of capital and labor more than double output. … The second assumption is that inputs other than capital, labor and knowledge (technology) are relatively unimportant."

[4949]Agenor and Montiel (1999, p. 679) argue, "The presence of externalities implies that if , say, one firm doubles its inputs, the productivity of the inputs of other firms will also increase. Introducing spillover effects leads to a relaxation of the assumption of diminishing returns to capital".

[50]Agenor and Montiel (1999 p.681) argues that proper government policies (subsidies)are important to address such market distortions and "to increase the equilibrium growth rate up to the level of the optimal growth rate".

from growth in human capital, infrastructure services and exports as we modeled in Chapter 1 above.

Second, in the money market, the constant income velocity of money assumption is relaxed replacing the quantity theory of the demand for money model with a modified cash-in-advance model that incorporates a structural change, exchange rate and interest rate variables in line with the analysis in chapter 2 of this thesis. In high growth countries with a rapid monetization process, the income velocity of money exhibits a continuous decline [Reinhart, 1991 pp.22-23]. The implication of this modification is that, by taking proper policy measures, the government could enhance financial deepening and raise domestic savings rate taking advantage of the responsiveness of money demand to changes in the structural change, interest rate policy and/or exchange rate policy variables[51] [McLoughlin and Noriaki, 2012 and Chenery, 1986].

The remainder of this chapter proceeds as follows: Section 3.2 presents motivation of the chapter followed by a brief historical background of the Ethiopian economy in Section 3.3. Section 3.4 discusses the basic theoretical foundation of a financial programming model. The modified financial programming model is covered in Section 3.5. This section presents a goods and services market, a money market, a foreign exchange market, and a model closure. Section 3.6 describes data and methodology. Estimations and interpretation of individual equations are presented in Section 3.7. Section 3.8 presents model simulation and forecast results. Finally, the chapter concludes by giving a summary and policy recommendations in Section 3.9.

3.2 Motivations of the Research

The last 10 years (2004 - 2013) economic growth performance seems to indicate that Ethiopia is well on track to achieve its ambition of joining the lower middle-income club in about 12 years, i.e., by 2025 by raising per capita income to about USD 1800. The

[51]Monetization implies that, on average, individuals and firms have seen increases in their holdings of real monetary assets per unit of income received. This means monetization endogenously determines the savings rate. Agenor and Montiel (1999, p.677) argues, "The assumption that the rate of growth of output is independent of the saving rates is also at variance with the evidence, which suggests that high-growth developing countries tend to have markedly higher saving rates (as well as higher investment rates and higher export volume growth rates) than middle- and low- growth countries."

economy managed to grow by close to 11 percent annual average for a continuous 10 years and, consequently, per capita income was increased almost by three-fold from USD 114 to USD 340 at current exchange rate. This has encouraged the government to declare that keeping the double-digit growth momentum is attainable. Accordingly, the first Five-year Growth and Transformation Plan (GTP I) set annual average real GDP growth rate at 11.2 percent, which is almost similar to the previous ten years' achievements. What is different this time however is the challenges that the economy is expected to face in keeping the growth momentum at the same level.

In the last ten years, double-digit growth was achieved without significant challenges in terms of both domestic and foreign financing because the investment programs were largely financed by booming exports and donor funds. In addition, the financing need was not challenging, in terms of size, compared with the level of growth it generated, as a significant share of the growth comes from increase in agricultural productivity that needed much less financial resources, particularly foreign exchange. A relatively small investment in smallholder farmers produced a big push in the sector.

When the GTP I was launched in 2011, however, the economy had already more-than-doubled following seven years of continuous growth at 11.4 percent between 2004 and 2010. In addition, the ambition of the government to transform from agriculture to manufacturing-led economy changed the dynamics of the resource requirement. Transformation to manufacturing-led economy requires huge investment in industries, infrastructure and other services that facilitate production. Foster and Morella (2011, p.1) argue Ethiopia's "greatest infrastructure challenge lies in the power sector, where a further 8,700 megawatts of generating plant are needed over the next decade, implying a doubling of the current capacity. The transport sector faces the challenges of low level of rural accessibility and inadequate road maintenance." As a result, the plan projected the required investment-to-GDP ratio to rise to 28.2 percent by 2015 from 22.3 percent in 2010 (just to maintain the same level of growth registered in the recent seven years prior to the plan)[52].

[52] Foster and Morella (2011) estimate that a sustained annual expenditure of USD 5.1 billion is required over the next decade (2011-2020) to address Ethiopia's infrastructure deficit.

This pushes the resource gap from 12.8 percent to 18.8 percent given domestic-savings-to-GDP ratio of 9.5 percent in 2010 [Federal Democratic Republic of Ethiopia, 2010].

Particularly, the foreign exchange demand seems to be the most challenging one. In the five-year plan period, annual average foreign exchange demand to finance major manufacturing and infrastructure investment projects in the private and public sectors (excluding agriculture, services, other private manufacturing sectors and government budget)[53] is projected at Birr 315.4 billion (USD 24.5 billion) [Federal Democratic Republic of Ethiopia, 2010]. The latter is about four-fifth of the entire foreign exchange that the economy generated in the recent five years prior to the plan, i.e., 2006 to 2010[54]. To ease the foreign exchange constraint, the plan aims at increasing annual earnings from exports of goods by four-fold to USD 8.0 billion in 2015 from about USD 2.0 billion in 2010 (which is 132 percent annual average growth). However, based on the experiences of East Asian Tigers and China, not a few literatures argue that, accelerating export growth requires favorable initial conditions in terms of human capital and infrastructure, and the need to make continuous investment in these sectors, along with outward re-orientation of the economy [Todaro and Smith, 2009; Agenor and Montiel, 1999; Chen, 1997 and Easterly and Serven, 2003][55]. Therefore, accelerating export growth at such unprecedented rate is going to be very challenging for an economy, which has the weakest infrastructure network in Sub-Saharan Africa and which depends mainly on exports of agricultural commodities such as coffee, oilseeds and horticulture for more than 75 percent of its foreign exchange earnings[56]. In 2010, total manufacturing exports accounted less than 5 percent of GDP [NBE, 2014].

[53]The National Bank of Ethiopia forecasted additional foreign exchange equivalent to USD 54 billion the projected amount for major sectors is needed in GTP I period to finance agriculture sector, services sectors, government budget and other non-priority public investment projects [NBE, 2011].

[54]During 2006-2010, the total foreign exchange generated, both through current and capital accounts of the balance of payments (including FDI), was estimated at USD 31.5 billion [NBE, 2011].

[55] Todaro and Smith (2009, p. 622) describes that "…for decades, Taiwan's total exports grew at an annual rate of over 20%, and exports from South Korea grew even faster. In both cases, this export growth was led by manufactured goods, which contributed over 80% of both nations' foreign-exchange earnings".

[56] In between 2006 and 2010, mineral exports such as gold and tantalum accounted 15 to 20 percent and manufactured goods exports contributed less than 10 percent of the total foreign exchange earnings of good exports.

Therefore, this chapter is driven by the following three research questions:

1. Are the declared policy targets, in GTP I internally consistent with the set of policy mixes announced in the plan?

This question wants to check whether the announced growth target is achievable or not given the policy packages prescribed in the plan.

2. Is it possible to raise domestic savings rate from 9.5 percent to 15 percent during GTPI, in a space of 5 years?

Unlike the traditional FP model, the MFP framework is not bound by a constant savings rate assumption. Therefore, the chapter wants to assess whether the savings target announced in the plan is achievable or the country faces unsustainable current account and fiscal financing gaps.

3. Is it possible to sustain the accelerated growth scenario until 2025 when Ethiopia will achieve its vision of joining middle-income countries' club?

In 2010, the government announced its resolve to sustain the pace of economic growth registered in the last seven years until the vision to bring Ethiopia to the lower middle-income status is achieved [Federal Democratic Republic of Ethiopia, 2010]. Hence, going to the future, the chapter wants to assess potential challenges and opportunities, particularly in terms of financing of investment. To this end, the chapter will simulate forecasts for the period (2014-2025).

3.3 Brief Historical Background of the Economy

3.3.1 The Socialist Regime (1975 – 1991)

Between the second half of the 1970s and early 1990s, Ethiopia's economy experienced abysmally low economic growth and severe macroeconomic imbalance since the country starts to produce national statistics. When the educated section of the society led by the then Haile Selassie University students started to revolt against the imperial regime in the

late 1960s, the aim was to replace the backward feudalistic socio-economic system by a modern and progressive one. However, at the height of the revolution, the military junta, known as the Derg, which was relatively organized and had military power hijacked the movement and declared a soviet-style socialist system in 1975. All private land and private capital whose value worth greater than Birr 500, 000 (about USD 241,000[57]) were all nationalized. Consequently, the production systems were organized in such a way that the main factors of production, land, labor[58] and capital are allocated according to national plan. The (then) Office of National Commission for Central Planning (ONCCP) centrally determined prices of labor, capital, financial services, and basic consumer items [Ayalew, 2001]. For instance, farmers were obliged to sell a certain portion of their basic food items such as teff[59]to the government at fixed prices, which were set well below the market prices[60].

Monetary and fiscal policies were relegated to supporting the centrally planned economy with financial institutions serving principally to meet the demand for credit by the central government and the public enterprises [Mohamed, 1996 and Geda 2001]. Monetary control was exercised directly, with bank credit allocated to accommodate plan targets. Interest rates and other market related instruments played limited role as transmission mechanisms for monetary policy. The private sector had been virtually denied access to credit. This is because government and public enterprises had been given first claim on financial resources even though they were used mostly for unproductive purposes. Increased reliance of the budget on central bank financing, injected record amounts of high-powered money creating liquidity overhang in the economy. Consequently, inflation hit 21and 22 percent in 1991 and 1992, respectively, despite the regime's fixed commodity prices and fixed exchange rate policies. Higher inflation also led the private sector to be engaged mostly in speculative activities rather than productive ones [Zeidy, 1994].

[57]Using the Birr/USD exchange rate of 2.07 in 1975.

[58]For instance, the ONCCP assigns university graduates to ministries and other government institutions irrespective of their will or type of trainings [Ayalew, 2001].

[59]Teff is a kind of cereal which is also staple food in Ethiopia

[60]In general, almost all market incentives for investment and production were removed and replaced by central planning.

Over the 17 years, the economy contracted in per capita terms by 1.9 percent on average per annum[61]. Despite various subsidies to boost exports and excessive control on imports through quantitative and tariff barriers[62], trade deficit continued to widen and reached -5.6 percent in 1991as percentage of GDP from a surplus of 1.4 percent in 1974. As a result, gross international reserves in months of next year imports of goods and services coverage went down to about three weeks by 1991.

As the foreign exchange and budget financing constraints intensified, the economy was forced to operate well below capacity. Towards the end of the Derg regime industries were estimated to operate less than 60 percent of their capacity due to shortage of imported raw materials and spare parts [Ayalew, 1994]. On the other hand, due to high share of recurrent expenditure in the budget, including on the military, roads, schools and hospitals barely got finance for maintenance let alone for investment in new infrastructure. On the political front, the regime's repressive and highly centralized system, in a country where there are more than 80 ethnic groups, led people to raise up arms and fight for their democratic freedom. Finally, both the economic and political pressures forced the regime to collapse in 1991 and replaced by a new government.

3.3.2 IMF Supported Economic Reform (1993 -2002)

When the new government led by the Ethiopian People's Revolutionary Front (EPRDF) took over power in 1991, despite its socialist background during its life as a guerilla-fighting group, it did not take long to realize that the socialist economic policy did not work and that the economy needed strong overhaul. In 1991, real GDP declined by 1.8 percent; annual headline inflation reached 22 percent; exports of goods and services declined by 30.7 percent; and, gross international reserves were barely enough to cover 3 weeks of imports of goods and services. Therefore, in the economic front, correcting the macroeconomic imbalance to curb inflationary pressure and boosting the country's gross international reserves to a sustainable level and undertaking structural reforms to help

[61]Real GDP was growing by an average annual rate of growth of 0.9 percent while population was estimated to grow by 2.8 percent on average.
[62]For some goods import tariffs exceeded 200 percent.

rebound economic growth became one of the long lists of priorities of the incumbent government. Consequently, in October 1993, an IMF-World Bank led Three-year Structural Adjustment and Economic Stabilization Program was launched [The Government of Ethiopia, 1998].

As is customary with a Fund supported adjustment program, the first task was to stabilize the economy, i.e., lower the rate of inflation, restore international competitiveness, reduce the current account of deficit, and check the loss of international reserves [Dercon, 2002 and Tashu, 2003]. Accordingly, a range of policy reforms was introduced. For instance, in October 1993, the Birr was devalued by 142 percent and subsequently allowed to be determined by a direct weekly auction system; price controls on commodities were lifted, import tariff bands were narrowed and rationalized; the nominal interest rate was raised to 10 percent from 6 percent. Credit ceilings were imposed on banks to mop up liquidity overhang. Moreover, measures to privatize selected loss-making public enterprises were introduced [Ayalew, 1994].

The reform program succeeded in bringing down inflation, improving the external trade balance by restoring international competitiveness, and rebuilding international reserves [The Government of Ethiopia, 1998]. At the end of the first year of the program, in 1993, annual average headline inflation was brought down to 7.7 percent from 21.9 percent in 1992 even 4.3 percentage points lower than the program target. Moreover, it declined further to 3.3 percent in 1994. On the other hand, exports rebounded by an annual average rate of growth of 60 percent over the three-year program period against 9.8 percent annual average decline in the preceding three years (before the program). During 1993-2002, the economy registered an average annual rate of growth of 4.5 percent.

3.3.3 Pre-GTP-I Development Programs: 2003 – 2010

As fiscal consolidation was given priority in almost all of the three successive IMF-led programs, implemented between 1993 and 2002, there was no explicit program that targets public infrastructure such as roads, power and telecom and/ or health and education. As a result, the productive capacity of the economy, particularly in terms of the quality and

quantity of infrastructure, showed little change from where it was in 1992. For instance, the total number of university graduates in 2001 was only 4,403, and net enrollment rate at primary level was 63.8 percent despite the rapidly growing population [Ministry of Education, 2015] while, in the physical infrastructure side, road density and total electricity installed capacity were only 30.3 per 1000 square km and 714 MGWs, respectively [IMF, 2011]. Given the potential of the economy, the government did not find the 4.5 percent annual average growth of the economy registered during 1993-2002 something to celebrate for a country that had been contracting at an average rate of 1.9 percent per annum in per-capita terms[63] for almost two decades prior to 1993.

Therefore, the government openly criticized the belief in the IMF-led reform programs that economic stabilization and structural adjustment policies would have a strong trickledown effect on growth through efficient allocation of productive resources and attractive investment environment ensuing the stability of the macro economy. The growth outturn did not satisfy its ambition to pull the economy out of abject poverty and embark on a high and sustainable economic growth path. Consequently, in 2003 government introduced a new three-year economic growth strategy called Sustainable Development and Poverty Reduction Program, and was subsequently followed by a five-year plan of Poverty Reduction and Sustainable Development Program (2006- 2010) [Federal Democratic Republic of Ethiopia, 2010 and World Bank, 2005].

The above two programs gave explicit focus on enhancing the economy's potential growth rate through increased investment on building physical and social infrastructure and raising productivity in agriculture. Annual average investment-to-GDP ratio jumped to 24 percent between 2003 and 2010 from 20 percent in the last 7 years (1995-2002) prior to the plan. Consequently, real GDP growth embarked onto a new trajectory. For instance, annual average real GDP growth reached 11.4 percent between 2004 and 2010[64], and merchandize exports growth surged to 23.5 percent from the previous seven years' average of 6.3 percent. In the infrastructure area, a total of about 11,000 km of high way roads, excluding new rural roads, were added to the national road network and the number of state owned

[63]Annual average population growth was estimated at 2.8 percent [Central Statistics Agency, Statistical Abstract, 1996].

[64]Real GDP shrank by about 3 percent in 2003 due to the severe drought that happened in the country.

universities more than doubled from 9 to 22 in the space of the five years between 2005 and 2010.

In the money market, however, the new high-growth scenario came with new challenges as pressure from the surge in domestic aggregate demand (resulting from continuous strong economic growth) built up. In combination with frequent changes in the dynamics of international food and fuel prices, it led to the annualized average national inflation jumping from 4.2 percent between 1997 and 2006 to 20 percent during 2007 to 2010. Despite the fact that the government succeeded in bringing inflation back to a single digit in 2009 and 2010, it has continued to pose a significant challenge to the monetary authorities. Consequently, the real exchange rate appreciated forcing the government to devalue the Birr by about 40 percent in a space of two years, from Birr 9.24/USD in 2008 to Birr 12.9/USD in 2010.

3.3.4 The First Five-Year Growth and Transformation Plan: 2011-2015

Having the successful experience of the previous two development programs, this time the Ethiopian government has set out a clear vision for the country that tries to spell out clear macro and micro-level growth and transformation targets. The first Five-year's Growth and Transformation Plan (GTP I) envisages transformation of the economy from agricultural to manufacturing base, and consequently, realize the government's vision of joining the middle-income group the latest by the year 2025. In the plan, annual average real GDP growth target set at 11.2 percent; inflation to be contained within single digit and gross international reserves coverage in months of next year's imports of goods and services is targeted not to go lower than 2 months. Policy packages and strategies targeted to achieve the plan targets are also announced.

Industry is forecast to grow at an annual average rate of 20 percent followed by services (10.6 percent) and agriculture (8.6 percent) [Federal Democratic Republic of Ethiopia, 2010 and IMF, 2011a and 2011b]. Recognizing the implication of these targets on the demand for power and other infrastructure, government plans to quadruple electricity generation

capacity from about 2000 MGWs in 2010 to 8000 MGWs, and extend the total length of roads from 48, 800 kilometers in 2010 to 64,500 kilometers (32.2 percent increase) by 2015[65]. During the same period, the railway network is planned to reach 2395 kilometers from zero[66]; mobile phone network access to grow from 8.7 percent to 45 percent; total drinking water coverage from 68.5 percent to 98.5 percent; primary school net participation rate from 87.9 to 100 percent and health service coverage from 89 percent to 100 percent. To this aim, the plan forecasts the required investment-to-GDP ratio to grow to 28.2 percent by 2015 from 22.3 percent in 2010. Total foreign exchange demand in the five-year's plan period (including private, budget and non-budgetary public sectors) is also forecast at about USD 78.5 billion. The latter is almost 2.5 times the total foreign exchange that the economy managed to generate between 2006 and 2010.

3.4 The Basic Theoretical Foundation of Financial Programming Model

Khan and Montiel (1989)'s growth oriented financial programming model is borne out of IMF's monetary approach to the balance of payments model originally developed by Polak (1957) and World Bank's 'two-gap growth' model formally known as Revised Minimum Standards Model (RMSM). IMF maintains the financial programming framework to help countries with inflationary pressure and balance of payments crises whereas the World Bank model focuses on establishing external financing needs in relation to medium-term growth targets[67]. The merged model therefore has three policy objectives: international reserves, inflation and growth. The model also employs a selected number of policy instruments such as domestic credit, exchange rate, tax, government consumption and availability of external financing (Bruce, 1999 and Khan and Montiel, 1989). Khan and Montiel (1989, p.279) argue that "a healthy and sustained rate of economic growth is

[65] Rapid transformation of the economy from agriculture to manufacturing base along with the continued fast integration of the rural economy is expected to aggravate the existing gap in power and transport.

[66]The old railway network which extends from Djibouti to Addis Ababa has already ceased operation due to old age.

[67]The model identifies financing gap given the required level of investment and domestic saving capacity. Therefore, it helps to estimate the level of foreign assistance required.

central to an adjustment strategy intended to achieve long-term viability in the balance of payments and a permanent reduction in the rate of inflation." The main intention of the model is, therefore, to give a conceptual framework that incorporates the most important macroeconomic policy instruments and targets, and at the same time could be tailored to the circumstances and structural characteristics of the individual country.

During the 1980s and 1990s, financial programming was widely used by the IMF to design macroeconomic policies for countries with domestic macroeconomic instability and external shocks such as capital account crises [Bruce, 1999 and Allen, 2004a&b]. Granville and Mallick (2005) ascribe the basis for the simplified framework to Polak (1957). Since Polak , a number of other Fund economists have contributed to the development of the framework, including Khan and Montiel (1989), Khan, Montiel and Haque (1991), Mikklesen (1998), Allen (2004a and 2004b). Polak (1957) squarely attributes balance of payments disequilibria to excessive domestic credit expansion. This arises from the fact that consolidated balance sheet of the banking system (in flow) holds the basic relationships between change in money supply (ΔM^S), change in international reserves in foreign currency (ΔR) and change in domestic credit (ΔD) in its identities as follows:

$$\Delta M^S = \Delta D + E\Delta R,$$

where E is the nominal exchange rate, which is assumed fixed. In the relationship, R and M are endogenous and D is a policy variable, exogenously determined by monetary authorities. On the other hand, the flow of demand for money assuming velocity of money constant could be expressed as:

$$\Delta M^D = \upsilon\Delta Y,$$

where υ is the inverse of income velocity of money, M^D money demand, Y is nominal GDP and 'Δ' is the difference operator. The money market is required to be in equilibrium in flow (not necessarily in stock) (Khan and Montiel, 1999) so that:

$$\Delta M^D = \Delta M^S = \Delta M,$$

For this simple model, we assume real capacity output ($\bar{Y}$) is exogenously determined[68], and we get the following expression:

$$\Delta Y \approx \Delta P\bar{Y}_{t-1} + P_{t-1}\Delta\bar{Y},$$

where P is domestic price index. We can now substitute the real capacity output equation into equation the demand for money function. Using the equilibrium relationship in the money market ($\Delta M^D = \Delta M^S$), we arrive at the change in international reserves equation as follows:

$$E\Delta R = \upsilon\Delta P\bar{Y}_{t-1} + \upsilon P_{t-1}\Delta\bar{Y} - \Delta D$$

The change in international reserves is the fundamental equation of the monetary approach to the balance of payments. The equation demonstrates that the balance of payments is expressed as the difference between the private sector's flow of demand for money and the flow of domestic credit. Hence, an increase in domestic credit, which is exogenously determined by the monetary authorities, would be offset by a decrease in international reserves. This implies domestic credit determines the fates of both domestic liquidity and balance of payments positions of a country [Granville and Mallick, 2005]. In addition, the government balance sheet, which is commonly known as the fiscal account, is also drawn into the relationship through its financing identity[69]. However, there is a common misconception that the emphasis on money and monetary policy in determining balance of payments outcomes implies that adjustment programs are 'monetarist' in character. Rao and Kumar (2009) argue that the concentration on monetary flow could arise at least from two grounds: one, the balance of payments is essentially a monetary phenomenon and two, the monetary identity contain important macroeconomic information.

Since Polak (1957), a number of Fund economists contributed to the development of the framework including Khan and Montiel (1989), Mikklesen (1998), Allen (2004a and 2004b). One of the acclaimed features of the financial programming model is its simplicity. Reinhart (1991) points out that the model is sufficiently simple to allow its application where data are limited. In addition, a programming exercise starts with the

[68]In the merged IMF-World Bank model, real GDP is defined as a capacity-output determined by a fixed coefficient Harrod–Domar production function. Discussion on the determination of capacity output is found in section 3.5.

[69] In the consolidated balance sheet of the banking system, domestic credit is the sum of private credit (D_p) and government credit (D_g).

objectives and derives the corresponding policies, with an emphasis on consistency.[70] In other words, unlike the traditional macroeconomic model, an FP model searches for the appropriate sets of policy instruments that helps to achieve the desired policy targets such as: long-term growth, inflation and international reserve. On the other hand, traditional macroeconomic models search for a set of variables such as equilibrium output, inflation and international reserves given available resources and policy instruments. In the latter case, potential growth rate, inflation and gross international reserves are treated as outcomes of the model, not as targets. Explaining the difference between the two approaches Bruce (1999, p.2) says that "a projection model asks 'what macroeconomic outcomes will result from a given set of policies?' while a programming model asks, 'what macroeconomic policies are required to achieve a given set of outcomes?' The specified outcomes include targets for inflation and foreign exchange reserves, consistent with a commitment to macroeconomic stability."

In this chapter, I follow the Mikkelsen (1998) approach of a financial programming model with structural equations. Mikkelsen (1998) develops a structural equation based financial programming model using El Salvador's data. The model has a goods and services market, a money market, a foreign exchange market and short-term supply and price determination blocks. Mikkelsen also applies the usual financial programming closures. Potential GDP, long-term inflation and gross international reserves are pre-determined targets in his model. However, in line with the analysis in Chapter 1 and 2, I have made two major modifications to the standard IMF model. First, in the goods market, I have replaced the neo-classical production function with an endogenous growth model in line with the model in Chapter 1. Second, in the money market, a modified cash-in-advance money demand model consistent with the analysis in Chapter 2 replaces the quantity theory of the demand for money model. Hence, in the modified financial programming model constancy assumptions of saving rate and velocity of money are

[70] "The consistency conditions are manifest in an interdependent set of macroeconomic accounting identities, including national accounts, the balance of payments accounts, financial-sector balance sheets, and the government budget constraint. Values of the various model parameters also have to be consistent with the structure of the economy and the designated policy objectives" (Bruce, 1999 p.2)

relaxed. The saving rate is assumed an increasing function of income whereas income velocity of money is a decreasing function of income.

3.5 The Modified Financial Programming (MFP) Model

The model is a simple macro model of a developing economy, with a goods and services market, a money market and a foreign exchange market. The markets are presumed to clear based on demand and supply interactions. However, unlike the traditional financial programming model in which equilibrium is instantaneous, in this model, by construction, the money and foreign markets are isolated from the effects of the goods market disequilibrium through endogenously determined financing gap variables, which are discussed below and, in addition, in section 3.5.2.3, section 3.5.4 and section 3.5.5 [Mikkelsen, 1998 and IMF, 2007]. Any disequilibrium in the goods market is reflected as financing gaps, i.e., saving-investment and foreign exchange financing gaps, instead of directly affecting the money and foreign exchange markets. That is, the model assumes the attainability of the planned growth target and ensures through the acquisition of additional foreign savings. The money market is assumed to clear with a lag determined by the magnitude of the adjustment coefficient in the short-run dynamic error correction money demand equation. On the other hand, the foreign exchange market is assumed to clear at all times. In this model, the exchange rate is fixed.

The long-term supply of products in the goods and services market is determined according to an endogenous growth production function that allows spillovers from infrastructure output and export growth in line with Chapter 1 of this thesis. Moreover, a spillover from investment in human capital is incorporated. The extent of all these spillover effects is endogenously determined using the respective behavioral equations. The long-term supply curve is assumed to be vertical while the short-term supply curve is upward sloping, so that the short-term supply of goods and services can differ from the long-term supply, with a corresponding divergence between short-term inflation and the long-term inflation target.

On the demand side of the goods and services market, private consumption, exports and imports of goods and services are defined by behavioral equations. Government consumption and government investment are treated as exogenously determined by policy. Private investment is determined as a residual between total required level of investment, which is determined by incremental capital output ratio (ICOR) technique, and public investment. The simple investment-output relationship, in the Revised Minimum Standard Model (RMSM), i.e., $\Delta K_t = \rho(Y_t^T - Y_{t-1})$, where ρ is the ICOR ratio, Y^T is target output and Y_{t-1} is actual output one year lagged, could be traced back to earlier growth models of the Harrod-Domar variety[Khan, et al., 1986]. RMSM relies on a savings rate and a given capital-output ratio to determine feasible levels of growth. If domestic saving is inadequate to meet the required investment needs of the economy for a target growth rate, that growth rate can be achieved only if foreign savings are available to make up the difference: if foreign savings fall short of the difference between domestic savings and the required level of investment, the target for growth cannot be achieved.

In financial programming models, a relatively general production function that allows for factor substitutions is allowed. Hence, in the FP case, the constancy of the ICOR arises from the assumption that the ratio of wages to the return on capital remains constant[71]. Khan, et al (1986, p.25) argue, "Dropping the assumption of fixed factor proportion for a smoother neo-classical production function allows knife-edge solution to be less likely".

Short run prices are determined in the money market through money demand and supply equilibrium. The demand for money is a behavioral equation similar to the one specified in chapter 2 except that the inflation expectations variable is moved to the short-run price determination block. The demand for money is subjected to a continuous monetization process with a declining income velocity of money. On the other hand, the money supply is determined as a product of the money multiplier and the supply of high-powered money. In the long-term, the money supply is set to be consistent with the inflation target. Given the money multiplier, high-powered money is determined endogenously using the money

[71]Wages and return to capital are assumed exogenous to be determined outside the model.

market equilibrium conditions[72]. The central bank manipulates high-powered money through the money market by trading of short-term securities.

It is worth noting that the modified financial programming model has endogenous resource gap variables, which are used to isolate short- and long-run variables from the effects of predicted lack of financing. Hence, the simulation results, including short-run aggregate supply (Q) and inflation, implicitly assume that the predicted resource gaps that are reflected as foreign exchange gaps or saving-and-investment gaps are fully met by additional inflow of foreign savings. Neither the resource gaps nor surpluses are linked with money market equilibrium nor goods market equilibrium. In other words, if the model predicts a financing gap, it would be reflected neither as lower money supply from the banking system (compared with the baseline) nor as government excess borrowing from the central bank. In all simulation scenarios, all the components of money supply, such as claims on government borrowing and gross international reserves, remain as assumed in the plan. Therefore, any disequilibrium in the money market reflects temporary deviations of the demand for or supply of money from their respective long-run equilibrium trends when one or more of their respective determinants temporarily deviates from long-run equilibrium trends. For example, appreciation of the exchange rate (compared with the plan) is expected to cause a temporary deviation of the demand for money from its long run trend.

On the other hand, in the goods market, required total investment is determined using the ICOR technique irrespective of the level of savings. A temporary increase in the required level of investment in relation to GDP from the long-run equilibrium trend affects neither money demand nor money supply despite the fact the deviation is expected to create excess demand for financing (compared with the baseline) because, the model endogenously reflects the projected excess demand as a resource gap, which is a separate variable. If the additional financing from abroad seems impossible to raise, one has to conclude that the plan is inconsistent and that the plan targets are unattainable. In other

[72]One of the main sources of change in high-powered money, i.e., change in net foreign assets of the central bank are it is one of the three key policy targets while change in claims on government is computed as a residual. Annex VI presents how the long-term equilibrium level of government borrowing from the central bank is determined.

words, it implies either the targets should be revised downwards or policy measures that could address the gap are needed[73].

The behavioral elements of the model are set out in this section in terms of long-run levels relationship, but the estimation and simulation exercises in section 3.7 and section 3.8 are conducted on first differences from which predicted levels are derived by cumulation. The complete model in the latter form, including its identities and cumulation equations is given in section 3.6.5. Section 3.6.5also defines the equation numbers, so that in this section the equation numbers are not a continuous series. Where equations appear here but not in section 3.6.5, they are marked with a prime.

3.5.1 The Goods and Services Market

3.5.1.1 Supply Side of the Goods and Services Market

3.5.1.1.1 Long-term Output Growth

In this chapter, long-term (potential) output is formulated in line with endogenous growth theory and on the analysis that has been provided in chapter 1. The production function in equation (1) is, therefore, specified as a function of capital stock (K), labor force (N), human capital development (H), infrastructure services (FQ) and export (X). The production function is permitted to exhibit increasing returns to scale to capital and labor factor inputs, as human capital stock and infrastructure output affects the productivity of these factor inputs [Agenor and Montiel, 1999, p.679]. In developing countries, export growth also raises the productivity of private capital and labor by providing economies of scale, technology transfer and improved managerial skill as discussed in chapter 1.

$$\ln Q_t = a_{11} + a_{12}\ln K_t + a_{13}\ln N_t + a_{14}\ln H_t + a_{15}\ln FQ_t + a_{16}\ln X_t + u_{1t} \quad \text{.....1'}$$

$$0<a_{12}<1;\ 0<a_{13}<1;\ \text{and}\ a_{14},\ a_{15},\ a_{16}>0$$

All variables are in real terms where 'ln' stands for natural logarithm; Q is potential (long-term) output (measured by real GDP); and K is total gross capital stock, which is the sum

[73]The model could easily be turned into a neo-classical equilibrium path model by dropping the endogenous gap variables, and linking the goods market to money and foreign exchange markets directly, without the intermediary foreign exchange gap and fiscal gap variables.

of private and public gross capital stocks. 'N' is labor; 'H' is human capital – the stock of skills; 'FQ' is services (outputs) of core infrastructures such as electricity, transport and communication and water and sewerage as defined by the World Bank 1994 [Wang, 2002]; and X is exports of goods and services.

For the financial programming model, potential output is an exogenously determined target (Q^T_t) which, if the growth rate is constant, could be specified as follows:

$\ln Q^T_t = \ln Q^T_{t-1}(1+g^T)$ ……..…….....…… 1

3.5.1.1.2 Capital Stock, Investment Requirement and Factor Productivity Growth

This section presents the determination of long-term level of capital formation and total factor productivity growth.

A. Total Capital Stock

The evolution of the capital stock (K) is governed by the identity in equation (2)

$K_t = I_t + (1-\sigma)K_{t-1}$…….……...……... 2

$I_t = I_{pt} + I_{gt}$…..……...……...……....3

where all variables are in real terms, I is gross total capital formation; I_p is gross private capital formation; I_g is gross public capital formation, and the parameter 'σ' represents the annual average rate of depreciation, which is assumed to be constant and to apply equally to both public and private capital stock.

B. Total Investment Requirement

The GDP growth target of the program is assumed constant over the long-term. Given the target rate of growth of output, the production function equation (1), defines the necessary inputs, so that given other inputs, the target rate of investment may be determined. In this model, long-term growth requires that the productivity-augmented capital-output ratio is either constant or decreasing, since an increasing path would imply convergence to a point

at which all domestic resources were used to keep the stock of capital at the level required by the growth target. The maximum growth rate is obtained at the point where the capital output ratio is constant (assuming that the capital coefficient is less than one) [Mikkelsen, 1998]. Hence, the long-term level of investment can be determined using a kind of incremental-capital-output-ratio (ICOR) technique by solving the first difference of equation (1) for ΔlnK, substituting $(\Delta K/K_{t-1})$ for ΔlnK and setting $u_{1t} = 0$.

$$\Delta K_t = [g^T - (\alpha_{13}\Delta \ln N_t + \alpha_{14}\Delta \ln H_t + \alpha_{15}\Delta \ln FQ_t + \alpha_{16}\Delta \ln X_t)]\, K_{t-1}/\alpha_{12} \quad \text{…….....……} \quad 5'$$

Using equations (2) and (3), we can rewrite equation (5') as

$$I_{pt} + I_{gt} = [g^T - (\alpha_{13}\Delta \ln N_t + \alpha_{14}\Delta \ln H_t + \alpha_{15}\Delta \ln FQ_t + \alpha_{16}\Delta \ln X_t)]\, K_{t-1}/\alpha_{12} + \sigma K_{t-1} \quad \text{…….....} \quad 5''$$

In developing countries, and particularly in Ethiopia, I_g is a policy determined variable associated with infrastructure and human capital development, so in the programming framework it is an exogenous variable. The latter implies that the sustainable level of private investment demand is endogenously determined as a residual in equation (5'') for a given growth target.

C. Total Factor Productivity Growth

C.1 Human Capital Development

Human capital (H) is specified as a function of public capital stock and real gross domestic output per head (Q/N). The latter represents the demand for labor or the economy's absorptive capacity.

$$\ln H_t = a_{21} + a_{22}\ln Kg_t + a_{23}\ln(Q/N) + u_{2t} \quad \text{…….....…..…..} \quad 6$$

a_{22} and $a_{23} > 0$

where K_{gt} is gross public capital stock, Q/N is real GDP per-capita, and human capital (H) is measured by gross school enrolment in junior-secondary school, senior secondary school and higher education. Thus, following Barro (1989), Mankiw, Romer and Weil (1992) and Loayza, Fajnzylber and Calderon (2005) human capital is measured in flow terms instead of stocks. In our case this is mainly because stock data are not available, but Loayza, et al

(2005, p.39) argue that "This flow measure more closely captures current policies on schooling and human capital investment than stock measures related to education attainment of adult population or life expectancy". In developing countries, government investment is expected to have a strong impact on human capital development, as it is the lead investor in education.

C.2 Infrastructure Output

In this model, infrastructure output (FQ) is assumed a function of public capital stock (Kg).

$$\ln FQ_t = a_{31} + a_{32}\ln Kg_t + a_{33}\ln N_t + u_{3t} \quad \ldots\ldots 7$$

$$a_{32} \text{ and } a_{33} > 0$$

Infrastructure output is determined by labor and the stock of capital in physical infrastructure such as roads and rail network infrastructure, airport and seaport infrastructure, electricity generation and transmission, and water and sewerage and telecom infrastructures.

C.3 Export Demand Equation

In line with conventional export models, exports of goods and services are specified as a function of real GDP and the real exchange rate.

$$\ln X_t = a_{41} + a_{42}\ln Q_t + a_{43}\ln REER_t + e_{5t} \quad \ldots\ldots 8$$

$$a_{42} > 0 \text{ and } a_{43} < 0$$

where a_{42} and $a_{43}$are long-run elasticities, and REER is the real effective exchange rate index as defined in equation (9) below. Exports of goods and services are expected to increase with real GDP and decrease when the real exchange rate appreciates. Although one can also add world economic prospects as an additional explanatory variable, given Ethiopia's insignificant share in total world trade volume, domestic supply and relative prices of exportable commodities are considered the only binding constraints in this model. World economic conditions affect Ethiopia's export performance through its impact on international prices of commodities, which is already captured by the REER.

REER is determined using the identity in equation (9).

$$REER_t = \sum w_{it} (e^f_{it}/e_t)(PD^f_{it}/PD_t) \quad \ldots\ldots 9$$

where $\sum$ is the summation operator and 'w' is a weight which measures the share of total trade (exports plus imports of goods) of a trading partner 'i' in total exports and imports of goods of Ethiopia. 'e' is the nominal exchange rate of the Birr in terms of USD, i.e., USD-to-Birr ratio; e^f is the exchange rate of a trading partner country in terms of USD; PD is domestic consumer price index; and PD^f is the consumer price index of a trading partner. Data on the top seventeen major trading partner countries, which collectively account for more than 80 percent of total trade, are used to construct the REER index (see Annex IV for details on page 249).

3.5.1.2 Short-Term Aggregate Demand

Equation (10) presents the short-term aggregate demand identity.

$$Q_t = C_{pt} + C_g{}^K{}_t + I_{pt} + I_g{}^K{}_t + X_t - Z_t \quad \ldots\ldots 10$$

where Q_t is real GDP; C_{pt} is real private consumption demand; C_{gt} is real government consumption demand; and Z_t is real imports of goods and non-factor services demand. The subscript 'K' indicates the variable is exogenously determined.

3.5.1.2.1 Private consumption demand

Private consumption demand is specified as a function of real disposable income and the real interest rate.

$$\ln C_{pt} = a_{51} + a_{52} \ln Y^d_t + a_{53} r + e_{5t} \quad \ldots\ldots 11$$

$$0 < a_{52} < 1; \text{ and } a_{53} < 0$$

Disposable income (Y^d) is determined as total income (Q) less income tax (T), as follows:

$$Y^d_t = Q_t - T_t \quad \ldots\ldots 12$$

The real interest rate (r) is endogenously determined using equation (13) below, where 'i' is the nominal interest rate, which is exogenously determined by policy, and Π is the domestic inflation rate.

$$r_t = [(1+i_t)/(1+\Pi_t) - 1] \quad \ldots\ldots 13$$

3.5.1.2.2 Government Consumption

Government Consumption (C_g) is a policy determined variables.

$$C_{gt} = C_g\_Q_t^K * Q_t \quad \ldots\ldots 14$$

where C_g_Q is the ratio of government-consumption-to-GDP ratio at time't', which is policy determined and the superscript 'K', signifies that the variable is exogenously determined.

3.5.1.2.3 Import Demand Equation

Real imports of goods and services demand (Z) is specified as a positive function of real GDP.

$$\ln Z_t = a_{61} + a_{62}\ln Q_t + e_{6t} \quad \ldots\ldots 15$$

$$a_{62} > 0$$

where a_{62} is the long-run elasticity parameter. In least developed countries, which rely heavily on imports of machinery, equipment and intermediate inputs, the exchange rate plays little role as a binding constraint to imports because imports do not have close domestic substitutes [Taylor, 1994]. Particularly in the case of Ethiopia, it is complicated to model the role of the exchange rate in the domestic market because of the existence of a relatively large parallel market for foreign exchange[74]. Therefore, for simplicity, I followed

[74] In countries which are characterized by frequent foreign exchange shortages, prices of imported items, particularly consumer goods, semi-finished goods and raw materials are largely determined by the exchange rate in the parallel market. For instance, during Ethiopia's economic program, despite a 144 percent devaluation of the birr from Birr2.07/USD to Birr5.0/USD, domestic inflation dropped from 22 percent in 1992 to 8 percent in 1993 [Ayalew, 1994 and Dercon, 2002]. Ayalew (1994, 181) argues that before the reform "the lion's share of consumer goods were imported either through the black market or franco-valuta,

Polak's original financial programming and World Bank's RMSM import models [Khan, et al, 1990, pp. 160-166].

3.5.2 The Money Market

In the money market, the long-term sustainable inflation target is determined by the equilibrium between demand for and supply of money. Therefore, in the FP framework, the policy determined money supply is set to match the long-run demand for money so that the money market clears in line with inflation and international reserve targets. However, in the short-run, money demand could deviate from money supply as a result of temporary deviation of short term aggregate supply from long term potential output, causing actual inflation to deviate from targeted inflation. On the other hand, as international reserves are a predetermined target, the model assumes that any long-term disequilibrium in the foreign exchange market is addressed through acquisition of additional inflow of foreign savings.

3.5.2.1 Money Supply

Equations (16) to (24) are a set of identities that determines the level of money supply in an economy. Equation (16) demonstrates that money supply (M^S), which represented by broadly defined money (M2), is the product of the money multiplier (m) and the reserve money (RM) of the central bank. RM, on the other hand, is the sum of net international reserves on the country (F_m) and central bank's net claim on government (D_{mg}). Other items net (OIN) of the central bank which changes with acquisition of own assets or its-own liability to economic agents is less predictable and estimated as a residual. International reserves and net claims on government both evolve through time according to the changes in them implied elsewhere in the model. In the financial programming framework, the change in claims on government (ΔD_{mg}) that is consistent with long-term growth target is determined in the money market (see Annex VI), whereas, the change in

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whose prices are obviously quoted at the parallel market level. Moreover, most of the public enterprises were operating below capacity due to shortage of foreign exchange." Therefore, depreciation of the official exchange rate had little impact on the relative prices of goods in the domestic market.

international reserves of the central bank (ΔF_m) is determined in the foreign exchange market(see section 3.5.4).

$M^S_t = m_t * RM_t$ 16

$RM_t = e_t * F_{mt} + D_{mgt} - OIN_t$ 17

$F_{mt} = F_{mt-1} + \Delta F_{mt}$ 18

$D_{mgt} = D_{mgt-1} + \Delta D_{mgt}$ 19

The money multiplier is defined by various ratios that are assumed either constant or variable by the government as policy instruments.

$m_t = (1 + cc_t)/[rqr_t (1 + sd_t + td_t) + cc_t + err_t]$ 20

$cc_t = CC_t/DD_t$ 21

$sd_t = SD_t/DD_t$ 22

$td_t = TD_t/DD_t$ 23

$err_t = ED_t/DD_t$ 24

where 'cc' the ratio of currency in circulation (CC) to demand deposit (DD); 'sd' is the saving deposits (SD) to demand deposit ratio; 'td' is the time deposits (TD) to demand deposit ratio; 'err' is the excess reserve (ED) to demand deposit ratio; and 'rqr' is the legal reserve ratio on bank deposits. The ratios in equation 20 to 24 are assumed constant.

Money supply changes when either the money multiplier (m) or the reserve money (RM) changes or both. The money multiplier (m) is policy determined. As the 'cc', 'sd', 'td' and to some extent 'err' are constant ratios, 'm' changes when the central bank changes the required reserves ratio (rqr) on bank deposits. On the other hand, high-powered (reserve) money changes either when claims on government (D_{mg}) or international reserves of the central bank (F_m) changes.

3.5.2.2 Money Demand

The long-run real money demand (M^d/PD) equation is specified as a function of disposable income, per-capita rural output ratio (PC-RUROUT), the real interest rate and the real effective exchange rate. Specification of the money demand equation is similar to the modified cash-in-advance model used in chapter 2which is selected there as the best fit

model for developing countries in the process of structural transformation. The only difference is that, following Mikkelsen (1998), inflation expectation is incorporated into the short-term aggregated demand and price determination block in this model.

$$Ln(M^D/PD)_t = a_{71} + a_{72}lnY^d_t + a_{73}lnPC\text{-}RUROUT_t + a_{74}r + a_{75}lnREER_t + u_{7t} \quad \ldots\ldots\ldots 25$$

$$a_{72}, a_{73} > 0 \text{ and } a_{74}, a_{75} < 0;$$

The demand for money is expected to increase with increases in disposable income and per-capita rural output while it decreases when the real interest rate increases or the real effective exchange rate appreciates.

Per capita rural output (PC-RUROUT), in turn, is determined using the identity in equation (26) below.

$$PC\text{-}RUROUT_t = (Y_{ag}\_Q^K{}_t * Q_t)/N\_RUR\_P_t \quad \ldots\ldots\ldots 26$$

where N_RUR_P is rural population and Y_{ag}_Q is the ratio of agricultural output (Y_{ag}) to total output at time‘t’. The superscript ‘K’ indicates that the ratio is exogenously determined.

3.5.2.3 Money Market Equilibrium

Equation (27) presents the money market equilibrium condition.

$$M^S_t = M^D_t \quad \ldots\ldots\ldots 27$$

In this model, as the components of the money supply (in equations 16 and 17) are either plan targets (such as net international reserves and net claims on the government) or policy determined variables (like central bank claims on other sectors and the reserve requirement ratio[75]); hence the money supply is *de facto* assumed constant both over the short run and

[75]Reserve requirement ratio is the only policy variable in the money multiplier equation as the other variables are assumed constant over the long run.

long run[76]. Hence, unplanned disequilibria in the money market arise only due to temporary deviations of the demand for money from its long run trend.

3.5.3 The Government Sector

Equation (28) below is the government budget constraint which shows that government gets income from tax and non-tax revenue (R), and external current and capital transfers (G_{cg}) and (G_{kg}) respectively. It spends its income on consumption of goods and services (C_g); and it pays interest on the central bank stock of borrowing (D_{mg}), the stock of commercial bank borrowing (D_{bg}) and holdings of treasury bills (B), at interest rate 'i'. It also needs to pay interest on the stock of foreign borrowing, F_g, at interest rate i^f, which is converted from foreign currency terms by nominal exchange rate, e_t. As usual, the government deficit needs to be financed by foreign borrowing ($e^*\Delta F_g$), commercial bank borrowing (ΔD_{bg}), central bank borrowing (ΔD_{mg}) or treasury bills sell (ΔB).

$$\Delta D_{mgt} = {C_g}^K_t + I_{gt} + i_t^f * e_t * F_{gt} + i_t * (D_{mgt} + D_{bgt} + B_t)^K - {R}^K_t - {G_{cg}}^K_t - {G_{kg}}^K_t - e_t * \Delta {F}^K_{gt} - \Delta {D_{bg}}^K_t - \Delta {B}^K_t - \Omega_{gt} \quad \ldots\ldots 28$$

The superscript 'K' indicates that the variable is exogenously determined while the subscript 't' signifies time. Now the challenge is that, in least developed countries, the government's capacity to mobilize tax and non-tax income is limited. Moreover, the projected bank and non-bank financing sources may not be large enough to meet the government's financing needs. On the other hand, as discussed in section 3.5.2.3, the financial programming framework limits government's access to central bank financing because of the money supply target. So, closure of the model can be ensured only by adding a variable called the government-financing gap (Ω_g), which is a measure of the degree of disequilibrium in the system.

[76]The policy challenge in developing countries is almost always for government to prevent money supply running ahead of demand. The supply of credit to the private sector is determined by the capacity of banks (outside the central bank) based on the capacity to create money. The latter is determined by the demand for credit and central bank policy, particularly the legal reserve requirement policy. Hence, private sector demand for credit has little role in determining excess supply of domestic credit.

The presence of the financing gap in the model implies that the objective of achieving the long-term growth target along with the targets for inflation and international reserves is possible only if the government can secure an additional flow of resources either from domestic or foreign savings. Otherwise, the government should revise its target growth and investment demand down to stay in line with its inflation and balance of payments targets. Only when $\Omega_g = 0$ can we say that the government meets its financing needs. Therefore, the extent to which $\Omega_g > 0$ assesses the feasibility of the plan at least from the fiscal perspective.

3.5.4 The Foreign Exchange Market

Ensuring a sustainable balance of payments position is one of the three pillars of a financial programming exercise. On the right hand side of equation (35), the sum of exports of goods and services (X), net foreign interest income for investment abroad (i^f*F), workers' remittances (W), foreign government transfers (G_{cg}) and foreign private transfers (G_{cp}) less imports of goods and services (Z) equals the current account of the balance of payments. The current account deficit could be financed either by external government borrowing (G_{kg}) or by external private borrowing (G_{kp}). On the other hand, accumulations of net external reserves by the government (ΔF_g), by the non-bank private sector (ΔF_p) or by the commercial banks (ΔF_b) all serve to lower the build up in the central bank's international reserves (ΔF_m). All variables in equation 35 are in foreign currency terms except exports and imports of goods and services, which need to be converted by the nominal exchange rate.

$$\Delta F_{mt} = (PD*X/e)_t - (PD*Z/e)_t + i^f*F^K_t + W^K_t + G_{cp}{}^K_t + G_{cg}{}^K_t + G_{kp}{}^K_t + G_{kg}{}^K_t - \Delta F_g{}^K_t - \Delta F_b{}^K_t - \Delta F_p{}^K_t + \Omega \quad \text{.....35}$$

where PD is domestic price index (GDP deflator) and the subscript K signifies that the variable is exogenously determined. In the FP framework, the change in international reserves is a predetermined policy target (ΔF_m). The economy is said to have a sustainable balance of payments position in the medium and long run when it is able to finance its current account deficits from its capital account surplus while maintaining the international

reserves target (F_m)[77]. On the other hand, if the current account deficit cannot be financed by the predicted capital account surplus, it must be reflected as a foreign financing gap (Ω)[78]. Therefore, the extent to which Ω is greater than zero defines the feasibility of the overall plan. Given the set of policies, positive Ω implies the government should try to secure medium term financing from foreign sources or cut its growth target consistent with the available financing to avoid getting into an unsustainable macroeconomic situation.

3.5.5 Saving and Investment Equilibrium

The saving and investment equilibrium can be derived from the aggregate demand identity following Khan, et al (1990). Doing some manipulation in equation 10[79], we get:

$$\Delta K_t = (Y_t^T - T_t - CP_t) + (T_t - CG_t) + (Z_t - X_t) \quad \text{10'}$$

Equation (10') indicates that domestic investment is the sum of private savings, public savings, and the inflow of foreign savings in the form of financing of net imports. It is clear that the solution to the fixed-factor production function in equation (5'), leads to a knife-edge solution for growth. The model avoids this problem if the economy is able to raise sufficient foreign savings to make up the difference between domestic savings and the required level of investment [Khan, et al, 1990].

Rearranging equation (10'), we get,

$$S_t = \Delta K_t + (X_t - Z_t) \quad \text{36}$$

where S is gross domestic savings.

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[77] In the short run, if the current account deficit is larger than foreign exchange inflows through the capital account, the country would be forced to finance the deficit by drawing down its international reserves. However, persistent financing through this means is obviously not sustainable indefinitely and so is likely to result in a balance of payments crisis in the medium run or sooner.

[78] Note that the government budget-financing gap (Ω_g), in section 3.5.3, is a subset of the balance of payments gap (Ω).

[79] From aggregate demand, $Y^T = Cp + Cg + I + X - Z$, solving for gross domestic investment, I, gives

$$I = Y^T - Cp - Cg + Z - X,$$

Adding and subtracting T (which cancels out each other) in the above equation, gives us:

$$I = (Y^T - T - CP) + (T - CG) + (Z - X).$$

Equation (36) suggests that domestic savings increase when exports grow faster than imports. When the rate of growth of exports manages to overtake the rate of growth of imports, the trade deficit shrinks, which indicates that the country starts to spend less on domestic consumption and increases its exports to the rest of the world [see Sekkat, 2012, Skott et al, 2012, Jarreau and Poncet, 2011 and Gala and Rocha,2009 for the details]. The latter, in turn, results in a rise in savings rate in the modern sector. For instance, Gala and Rocha (2009) found that competitive exchange rate increases profit margins in the tradable sector and this leads to a rise in aggregate domestic savings.

Equations (37) to equation (40) present various identities of the savings and saving-investment gaps.

Gross national savings (S_NTL):

$$S\_NTL_t = \Delta K_t + (X_t - Z_t) + e_t*[i^f_t F_t + W^K_t + G_{cp}{}^K_t + G_{cg}{}^K_t] \quad \ldots 37$$

Saving –Investment gap (S_I_NTL) before financing from available foreign savings:

$$S\_I\_NTL_t = S\_NTL_t - \Delta K_t \quad \ldots 38$$

Available foreign savings (S_FORGN)

$$S\_FORGN_t = [G_{kp}{}^K_t + G_{kg}{}^K_t - \Delta F_m{}^K_t - \Delta F_g{}^K_t - \Delta F_b{}^K_t - \Delta F_p{}^K_t]*e_t \quad \ldots 39$$

Saving-Investment gap (S_I) after financing from available foreign savings:

$$S\_I_t = S\_I\_NTL_t + S\_FORGN_t \quad \ldots 40$$

3.5.6 Aggregate Supply and Prices

The FP framework allows the deviation of short-term aggregate supply from long-term aggregate supply. The long-run aggregate supply curve is vertical while the short-run supply curve is positively slopping. Any deviation of short-run aggregate supply and inflation from their respective long-term targets and would be corrected through fiscal and

monetary policies[80]. This implies that while short-term aggregate supply exceeds the long-term trend, short-run inflation will also exceed the long-term target. The central bank will correct disequilibrium in the money market either by changing its high-powered money target or the legal reserve requirement ratio. Interest rate policy is also an option but the problem in least developed countries such as Ethiopia, where there is credit rationing, is that it is difficult to identify the relationship between interest rate and investment demand [IMF, 2007, Bruce and Stiglitz, 1990 and Ali and Deininger, 2012]. In addition, as investors generally face high internal rates of return in these counties the interest rate rarely behaves as a binding constraint to investment demand. From the fiscal policy side, the government could use tax rates and government consumption to affect short-term aggregate output.

Studies indicate that, in less monetized economies least-developed countries, where food accounts more than half of the consumption expenditure basket, short-term inflation could be affected through three channels. The first channel is through the money market. When the supply of money exceeds the demand for money, it creates excess aggregate demand and pushes prices up in the short-term. The second channel is through imported inflation. Developing countries' consumer price indices, particularly in countries with larger food shares in the consumer baskets, are highly sensitive to changes in international food prices (Durevall, et al, 2013). The 2006-2007 and 2010-2011 international food and fuel price shocks affected Ethiopia badly by pushing consumer prices higher (Durevall, et al 2013 and Birru, 2007). Consumers have relatively long memories for inflation. Hence, inflation expectations is the third channel. Once prices deviate from the long-run trend, the memory lingers for some time and affects current price formation.

$$\Pi_t = \Theta_1 EX\_AD_t + \Theta_2 \Pi^f_t + \Theta_3 \Pi^e_t \quad \ldots\ldots 41$$

[80]In "steady-state", where the inflation rate is constant, short-term output growth equals potential growth, as determined by the production function in equation (1').

where Π is short-term inflation, EX_AD is proportionate deviation between the demand for and supply of money, Π^f is foreign inflation and Π^e is expected inflation. Θ_i is weight attached to the contribution of channel 'i' (to inflation). Mikkelsen (1998) in his financial programming model uses deviation of short-term aggregate output from long-run trend output (Q/QP-1), to measure excess aggregate demand instead of deviation. Moreover, inflation expectation is measured as a weighted sum of inflation target and past-inflation rates. On the other hand, in this model, short-term inflation is determined in the money market by the deviation between the supply of and demand for money.

$$EX\_AD_t = (M^S_t - M^D_t)/ M^D_t \quad \text{..... 42}$$

Money market disequilibrium is estimated to explain between 30 to 40 percent of headline inflation in Ethiopia (Birru, 2007). On the contrary, in the Durevall, et al (2013) model, excess money supply is found insignificant and does not seem to have a direct long-run impact on inflation in Ethiopia. However, Durevall, et al (2013) argues that the finding does not mean excess money is not an important determinant of inflation in Ethiopia; rather it could be due to the use of a small sample (11 years of monthly data) [Durevall, et al, 2013. p.14].

Foreign inflation or imported inflation is computed as the percentage change in consumer prices of major trading partner countries. The weighted sum of 6 major trading partner countries' consumer price indices, which have significant trade relation with Ethiopia on agricultural commodities, is used as proxy to world food price index (WPF)[81] (see Annex IV.2.4) on page 198).

$$\Pi^f_t=(WPF_t - WPF_{t-1}) / WPF_{t-1} \quad \text{..... 43}$$

Inflation expectations follow an adaptive expectation process by which expected inflation is a weighted average of the inflation target and the previous year's actual inflation. The central bank is to announce its inflation target at the beginning of each fiscal year, and the

[81]The six countries are China, India, Saudi Arabia, Turkey, Kenya and Djibouti.

public is assumed to use this information, along with the memory of the previous year's inflation to form its expectations.

$$\Pi^{e}_{t} = \upsilon\,[(PD^{T}_{t}/PD^{T}_{t-1}) - 1] + (1-\upsilon)^{*}\,[(PD_{t-1}/PD_{t-2}) - 1] \quad \ldots\ldots 44$$

where, PD^{T} is target domestic price index; PD is actual domestic price index; and υ is the weight attached to the contribution of inflation target on people's formation of inflation expectation.

3.5.7 Model Closure

As set out above, the model contains 46 endogenous variables: 7 behavioral equations, which are estimated below and 39 identities; 43 exogenous and 3 policy objective variables, i.e., potential output (Q), inflation (Π) and change in gross reserves of the central bank (ΔF_m) which, in the financial programming context, are set, equal to target values. No automatic adjustment to equilibrium in balance of payments and fiscal accounts as the exchange rate (e) and the domestic interest rate (i) are assumed fixed. Imbalances in the balance of payments and government budget are reflected in the foreign financing gap (Ω) and the government budget financing gap (Ω_g). Table 3.2 gives a full listing of variables.

$$Q^{T}_{t} = Q^{T}_{t-1}(1 + g^{T}) \quad \ldots\ldots 1$$

$$\Pi_{t} = \Pi^{T}_{t} \rightarrow PD_{t} = PD^{T}_{t-1}\,(1 + \Pi^{T}_{t}) = PD^{T} \quad \ldots\ldots 45$$

$$\Delta F_{mt} = \Delta F^{T}_{mt} \quad \ldots\ldots 46$$

$$e_{t} = e^{k}_{t} \quad \ldots\ldots 47$$

$$i = i^{k}_{t} \quad \ldots\ldots 48$$

As the objective of this modified financial programming model is to check internal consistency in the medium term plan, it does not have closures in the normal modeling sense of a set of assumptions that allow all the endogenous variables to be fully determined given the exogenous ones in a mutually consistent fashion. Rather it determines two endogenous variables – the financing gaps in the government sector and the foreign exchange market – that indicate the likely extent of disequilibrium in the model – the inconsistency between the various assumptions and plan targets. If the financing gap

variables are other than zero, the government's growth plan is deemed infeasible and something must be adjusted. This may involve changes in certain policy instruments – e.g. the tax rate, exchange rate or government consumption – or a change in targets.

The previous paragraph should not be taken as suggesting that there is no adjustment in the model, however. In the goods market, the long-term level of investment is determined applying a kind of incremental capital-output (ICOR) principle. After exogenously determining the level of total government investment, private sector investment is computed as a residual using the technical relationship of the production function (equation 5''). This implies that, as a typical feature of a financial programming model, the government fiscal operation crowds out private sector activities in the medium and long-term. Otherwise, it may potentially undermine sustainability of the medium-term macroeconomic stability scenario of the program. If aggregate demand goes above long-run productive potential, short-term aggregate supply can expand temporarily beyond its long-term level, and this is reflected in a deviation of short-term inflation from target inflation. Through the effects of the latter, domestic prices serve as an adjustment factor in the goods markets.

3.6 Data and Estimation Methodology

3.6.1 Data

The purpose of the model is to explore aspects of economic policy facing the Ethiopian government. For this purpose the parameters of the behavioral equations need to be estimated, which I do equation-by-equation using annual time series from 1971 to 2013. Table 3.2, in Section 3.6.4 below, presents the endogenous and exogenous variables and policy instruments employed in the model. I am able to use official data produced by the National Bank of Ethiopia (NBE), the Central Statistics Authority (CSA) and the Ministry of Finance and Economic Development (MOFED) to cover the full set of variables. Precise sources and definitions of the main variables are given in Table 3.1 below and the full list of variables is provided in Annex 3.1.

Table 3-1: Definition of Variables and Sources of Data

(In Local Currency Unless Otherwise Specified)

Name of the Variable	**Definition of the Variable**	**Source of Data**
BBGROSL _USD	NBE'sGrossForeign Liability (in USD)	NBE's Annual Reports
BBGROSR _USD	NBE's Gross International Reserves (in USD)	"
BBNFA	NBE's Net Foreign Assets	"
BBNGOV	NBE's Net Claims on Gov't	"
BBNPVT	NBE's Net Claims on the Private Sector	"
BBOIN	Other Items Net of the NBE	"
CBNFA_USD	Commercial Banks's Net Foreign Assets (in USD)	"
CBNGOV	Commercial Banks' Net Claims on Government	"
CBNPVT	Commercial Banks's Net Claims on Private Sector	"
CG	Real Government Consumption	MOFED's National Accounts
CP	Real Private Sector Consumption	"
CUACB_USD	Current Account of the BOPs (in USD)	NBE's Annual Reports
DEF	GDP Deflator (2011 = 100)	MOFED's National Accounts
E	Nominal Exchange Rate of the Birr (Birr/USD)	NBE, Annual Reports
F	Real Infrastructure Output	MOFED's National Accounts
F_BOR_NET _USD	Official Net Foreign Borrowing From Abroad (in USD)	NBE's Annual Reports
F_BOR_OTH _NET_USD	Other Sectors Net Foreign Borrowing From Abroad (in USD)	"
FDI_USD	Foreign Direct Investment (in USD)	"
FYNETW_ USD	Net Foreign Income from Abroad (in USD)	"
GOVCAP_E	Government Capital Expenditure	MOFED's Fiscal Statistics
GOVCON_E	Gov't Consumption Expenditure	"
GRANT	Official Grants	"
H	Human Capital Index	Computed from CSA's Reports

Table 3.1 (Cont'd): Definition of Variables and Sources of Data

(In Local Currency Unless Otherwise Specified)

Name of the Variable	**Definition of the Variable**	**Source of Data**
IG	Real Gross Gov't Capital Formation	MOFED National Accounts
INTRATE	Minimum Interest Rate	NBE's Annual Reports
IP	Real Gross Private Capital Formation	MOFED, National Accounts
M	Broad Money Multiplier	NBE's Annual Reports
M0	High-powered (Reserve) Money	"
M2	Broad Money Supply	"
N_RUR_P	Total Rural Population of Ethiopia	CSA Reports
N_TOT_P	Total Population of Ethiopia	"
N_URB_P	Total Urban Population of Ethiopia	"
NFA	Net Foreign Assets of the Banking System	NBE's Annual Reports
NTX	Non-Tax Revenue of the Government	MOFED, National Accounts
OFFTRANSW_USD	Official Transfer(in USD)	NBE's Annual Reports
OIN	Other Item Net of the Banking System	"
PC_RUROUT	Per-capita Rural Output	MOFED, National Accounts
PD	Consumer Price Index (2011 = 100)	NBE's Annual Reports
PVTRANSW_USD	Private Transfers (in USD)	"
Q	Real GDP (Actual)	MOFED, National Accounts
QP	Real Potential Output	Federal Democratic Republic of Ethiopia, 2010
S	Real Gross Domestic Savings (Public plus Private Savings)	Computed from MOFED's National Accounts
SHT_CAP_USD	Short-term Capital Net Inflows (in USD)	NBE's Annual Reports
TX	Total Tax Revenue	MOFED, Fiscal Statistics
TX_Y	Total Income Tax Revenue	"
X	Real Exports of Goods and Service	MOFED, National Accounts
Z	Imports of Goods and Services	NBE's Annual Reports

Recently, there has been a good deal of controversy between the Ethiopian Authorities and the IMF over the accuracy of the national accounts data. Specifically, this was concerned with the GDP estimates. However, after a long

discussion to resolve the disagreement and produce an agreed set of data, the IMF finally have confirmed that the Ethiopian Authorities' data measure economic activity reasonably and have accepted the official series[82].

Getting official statistics on capital stock data is a basic problem in developing countries. Therefore, I use the technique similar to Nehru and Dhareshwar (1993). This technique is commonly called 'the perpetual inventory method'. It argues that 'capital stocks is the accumulation of the stream of past investments'. If one assumes that a given capital stock depreciates at proportionate rate σ per annum, this implies that the average life of investment made in year X equals $1/\sigma$. The initial capital stock (K_0) could therefore be estimated by dividing initial gross total investment (I_0) by σ. The limitation of this technique however is that it assumes annual stream of investments in the last $1/\sigma$ years were equal. Once K_0 is determined, successive year capital stock values are derived using equation (2) by adding the current level of gross total domestic investment (I_t) onto one period lagged net capital stock, $(1-\sigma)K_{t-1}$. Nehru and Dhareshwar (1993) estimate that σ is roughly between 0.03 and 0.04. In this chapter, the former - a 3 percent annual average depreciation rate - is assumed.

In many developing countries, time-series data on employment is not available. Hence, similar to the studies in most LDCs, I use total population data obtained from the Central Statistics Agency as a proxy to labor stock (N) [Ram, 1987]. Human capital (H) is defined as the fraction of time that labor spend to acquire skill (Agnor and Montiel, 199, p. 680). In this chapter, H is computed as total number of students in 7th grade and above including university graduates obtained from Central Statistics Agency and Ministry of Education.

[82]The IMF expressed its concerns in very sweeping ways such as 'growth is overestimated by 2-3 percentage points'. The statement does not indicate where the sources of weaknesses are. Neither, it gives details of those estimates.

Figure 3-1: Plots of Selected Variables of the Model for the Period (1971-2013)

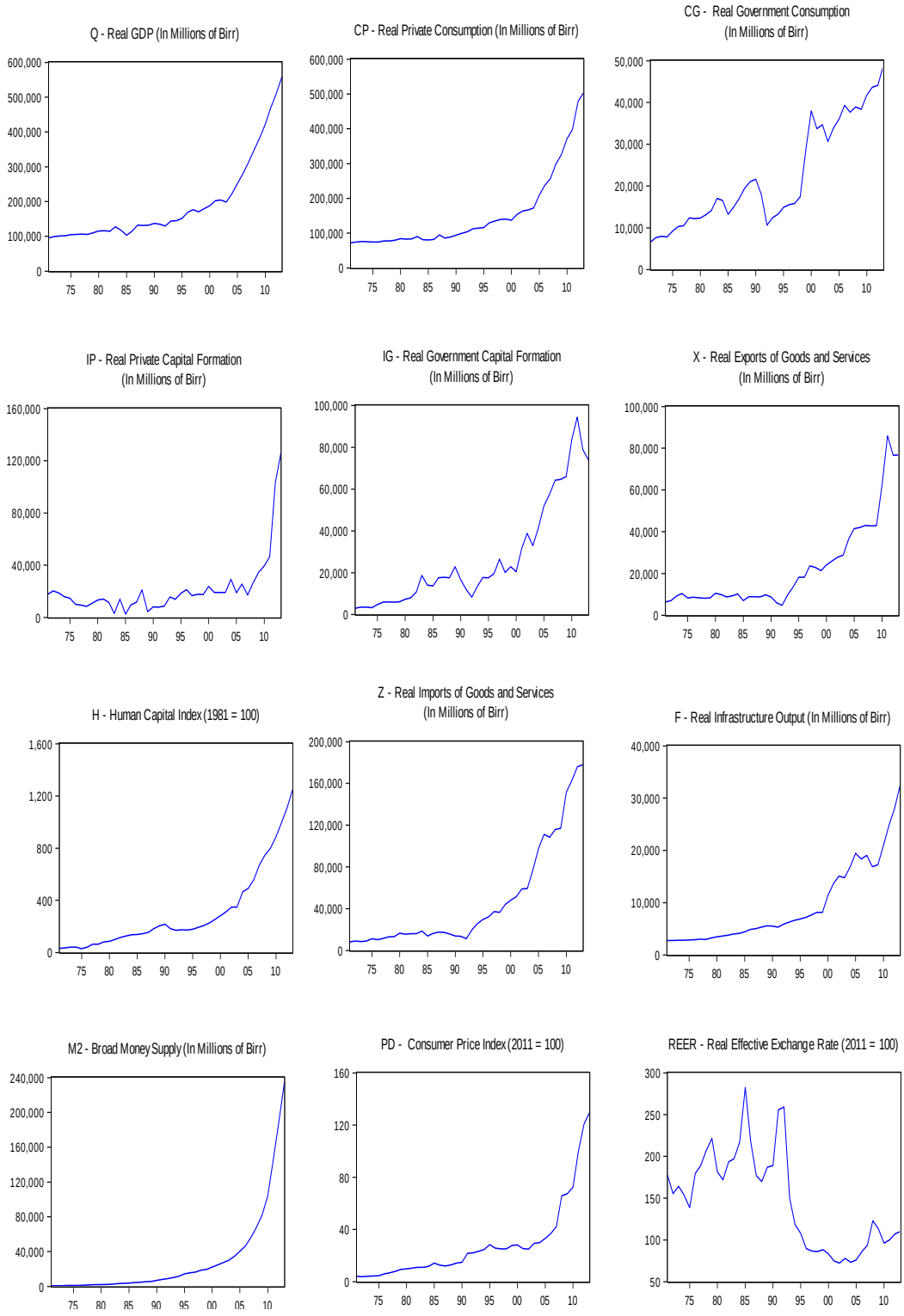
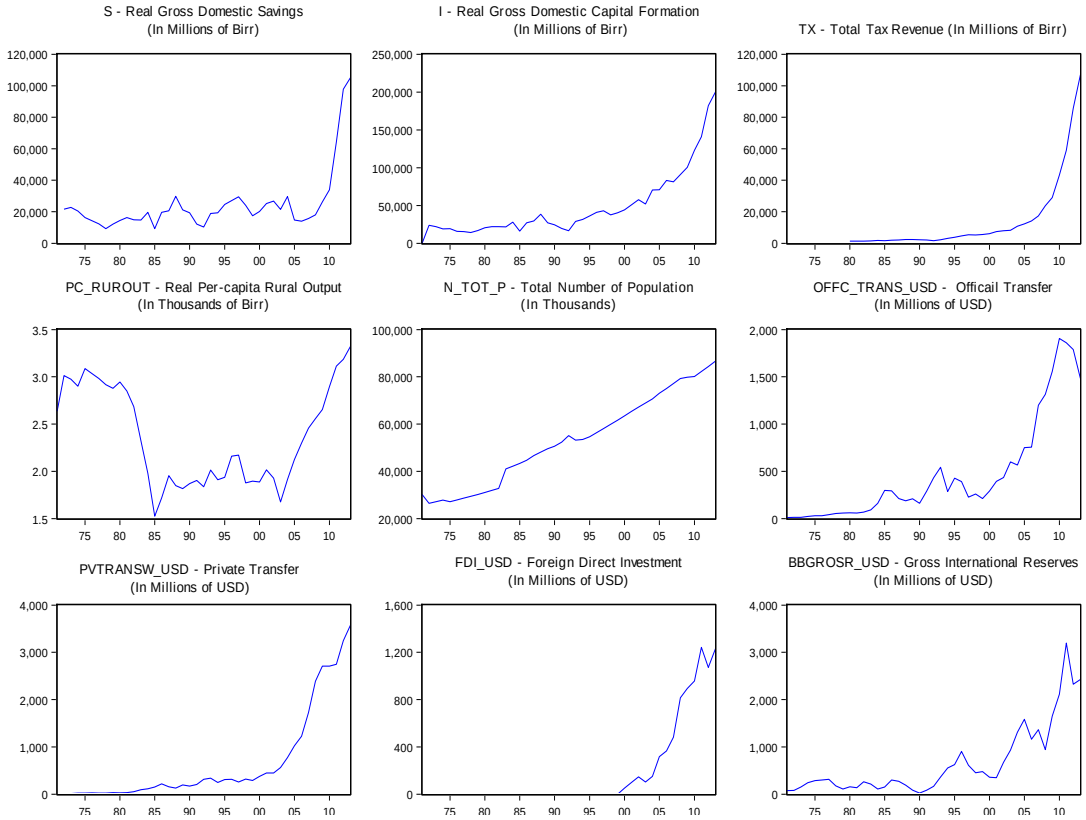


Figure 3.1 (Cont'd): Plots of Selected Variables of the Model for the Period (1971-2013)



Figures 3.1 (below) depict the evolution of selected variables in the model. Close inspection of main variables indicates presence of three distinct periods in the speed of economic growth that confirms the discussion in section 3.3. For instance, real GDP, consumption, gross fixed investments (both public and private), human capital and infrastructure output plots are relatively flat between 1971 and early 1990s indicating stagnation in economic activities during the period. Then, the slopes of the curves show a moderate rise between 1993 and early 2000 following the IMF-World Banks supported economic reform program but remain subdued until 2003. On the other hand, government consumption declines during the period reflecting the program's focus on fiscal discipline between 1993 and 2002. Then comes the third episode, which is the period between 2004 and 2013. In this period, almost all variables in the real, external and fiscal sectors experienced steeper slops reflecting the effects of accelerated economic growth.

Real domestic savings and tax revenue depicts a relatively longer period of stagnation compared with other main economic variables. Both of them show sharp rises only from 2007 onwards.

3.6.2 Methodology

3.6.2.1 The Econometric Estimation Procedure

The behavioral equations are estimated one-by-one using the short-run dynamic error correction method. Following Bahmani-Oskooee and Rehman (2005) and Peresan et al (2001), each equation is specified as a single equation autoregressive distributive lag (ARDL) format as follows:

$$\Delta y_t = \sum_z \theta_z \Delta y_{t-z-1} + \sum_i \sum_z \kappa_{iz} \Delta x_{it-z} + \alpha_1 [y_{t-1} - \sum_i \beta_i x_{it-1} - \beta_0] + u_t \quad \ldots\ldots 49$$

where i = 1 … n refers to explanatory variables included in the equation and z = 0…. Z counts over time-periods, with Z equal to the maximum lag. y_i is the dependent variable, x_i are explanatory variables (regressors); θ_z and κ_{iz} are the short-run coefficients and β_i are the long-run coefficients. α_1 is the speed of adjustment or the error correction term and the expression in bracket represents the long-run vector.

The ARDL approach is very suitable to the formulation of single equation time series models because, unlike the standard cointegration tests, there is no need for unit root pre-testing [Bahmani-Oskooee and Rehman, 2005 and Pesaran, et al, 2001]. In addition, a study by Gerrard and Godfrey (1998, p.235) finds that 'the ARDL approach provides not only better estimators of the long-run coefficients but also more reliable diagnostic procedures for the derived ECM' than the Engle-Granger variant. They also argue that although both Engle-Granger and ADL methods yield super-consistent estimators of long-run coefficients, because of small sample biases, the LM test for autocorrelation and the RESET test may be severely oversized when applied to the equation of the Engle-Granger variant.

The asymptotic theory that Pesaran, et al, (2001, p.315) developed offers "a simple univariate framework for testing the existence of a single level relationship between y_i and x_i when it is not known with certainty whether the regressors are purely I(0) or purely I(1) or mutually cointegrated". The null hypothesis is defined as H_0: $\alpha_1 = 0$, that is no level relationship or no cointegration and is tested against the alternative that H_0: $\alpha_1 \neq 0$, using an F-test. Pesaran et al's (2001) bound testing approach provides lower bound and upper bound critical values for the F-statistics. The lower bound assumes that all variables are I(0) and the upper bound that all variables are I(1).Accordingly, testing the error correction term, α_1, against the critical values using a F-statistic tabulated in Pesaran et al, (2001) provides the answer as to whether there is a long-run relationship or not. If the calculated t-statistic lies above the upper bound, the null will be rejected, and confirm presence of the long-run cointegrating vector in the model [Bahmani-Oskooee and Rehman, 2005].

To find the parsimonious model with the appropriate lag length, I rely on the Akaike Information Criteria (AIC). In addition, due to the absence of a sufficiently long data series, the maximum lag length is pre-determined. The lag length is set at 3 in the case of long-term output and money demand equations which are expected to have relatively quick convergence to equilibrium and have relatively large number of explanatory variables. For the remaining equations, the lag lengths are allowed to go up to 5 due to the relatively longer-gestation period. For example, human capital equation is allowed to have 5 lags because of the long gestation period needed in acquiring skill in formal education.

3.6.2.2 Diagnostic Checks

As explained in section 3.6.2.1, ARDL models yield super-consistent estimators of long-run coefficients. However, estimation of such models using OLS estimation method requires adherence to the standard assumptions about the distribution of the disturbances and the exclusion of relevant regressors. There is therefore a need to check for misspecification to assess data consistency of the ARDL models [Gerrard and Godfrey, 1998]. Diagnostic tests such as normality, autocorrelation, heterosckedasticity and misspecification of functional forms tests are conducted on the residuals of the estimated model. One of the tests is the Jarque-Bera normality test. The Jarque-Bera test statistic has

a chi-square distribution with 2 degrees of freedom. If the null hypothesis of normally distributed errors is rejected, it indicates that the inference we make about the coefficient estimates could be wrong.

The second test is for the misspecification of the functional form. Although all the behavioral equations are specified in log-transformed form, there is still a chance that the correct functional form is non-linear in parameters. Ramsey's RESET test is used to the test for misspecification of functional form. The test has a chi-square distribution. The third test is for serial correlation (autocorrelation), which we make using the Breusch-Godfrey Serial Autocorrelation test. Greene (2000, p.736) states that 'the usual explanation of autocorrelation, in ARDL models, is serial correlation in omitted variables'.

The fourth test is the heteroskedasticity test. Although there is less probability of detecting heteroskedasticity problems in time series models, if it happens that the magnitude of the residuals is related to the magnitude of the recent residual, the test statistics would be less efficient. The chapter applies autoregressive conditional heteroskedasticity (ARCH) LM, which is recommended by Gerrard and Godfrey (1998) for ARDL models.

Finally, there is always a chance that a set of variables is basically cointegrated but may also be subjected to a finite number of permanent shocks to either variables or parameters values. Hence, I also conduct cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests on the residuals of the estimated equations to test for shocks and/or permanent changes in the long-run elasticities. The CUSUM and statistics are based on the one-step ahead prediction errors, i.e., the differences between the dependent variable (y_t) and its predicted value based on the parameters estimated at time t-1 [Brooks, 2008].

3.6.2.3 Structural Break Tests

As Ethiopia has gone through three political and economic regimes in the last four and half decades, some relationships or variables are likely to be subject to structural breaks. Therefore, I carry out a simple covariance analysis differential intercept and "interaction variables" [Greene, 2000 and Gujarati, 2004]. The test helps to identify whether a

structural shift has taken place in the economy or sub-section of the economy at any point within the sample period. The test is conducted only on the long-run equation of the model. Equation (25') below illustrates how, for example, a structural break test could be conducted on the demand for money equation (equation 25), in section 3.5.2.2.

$$\Delta\ln(M^D/PD)_t = \sum\beta_{71}\Delta\ln(M^D/PD)_{t-m-1} + \sum\beta_{72}\Delta\ln Y^d_{t-m} + \sum\beta_{73}\Delta\ln PC\text{-}RUROUT_{t-m} + \sum\beta_{74}\Delta r_{t-m} + \sum\beta_{75}\Delta\ln REER_{t-m} + \alpha_{71}[(\ln(M^D/PD)_{t-1} + \alpha_{72}\ln Y^d_{t-1} + \alpha_{73}\ln PC\text{-}RUROUT_{t-1} + \alpha_{74}r_{t-1} + \alpha_{75}\ln REER_{t-1} + \alpha_{76}(D^*\ln Y^d_{t-1}) + \alpha_{77}(D^*\ln PC\text{-}RUROUT_{t-1}) + \alpha_{78}(D^*r_{t-1}) + \alpha_{79}(D^*\ln REER_{t-1}) + \alpha_{791}D + u_{792t}] \quad \text{..... 25'}$$

where D is the dummy variable, given zero, for example, to the 1971 – 2006 period and one to the 2007 -2013 period. The dummy variables are both additive and multiplicative to allow for differential intercepts and differential slopes respectively. The challenge in this technique is to identify the time when the structural break is likely to have occurred, especially if there could have been more than one break point in a sample, associated with either policy changes, regime changes or other shocks of permanent nature. Therefore, prior information (knowledge) about the possible break points or variables that are believed to be subject to structural shifts plays important role in conducting the test on the selected basis. The shifts in political and policy regimes are obvious candidates for example.[83]

Once the possible break points or variables are selected, equation (25') will be estimated repeatedly each time by changing assumptions about the period and/or the variable. For instance, if the suspected break years are 2004 and 2007, first the model will be estimate assuming structural shift happens in 2004. In this case, D takes zero for the period between 1971 and 2003, and one for the remaining period, i.e., 2004-2013. The model will be estimated again changing the assumption for the break point to 2007. In the latter case, D will take zero for the period 1971-2006 and one for the remaining. Having completed the estimations, the next step is to compare the different models using significance tests, normally a t-test, on the coefficients of the structural break variables and choose the model with the most significant coefficients.

[83] Khan (1980) tests the stability of the demand for money in Pakistan using this technique.

3.6.2.4 Single Equation Based Structural Model vs. Simultaneous Equation Model

I use the single equation method to estimate individual equations and then simulate them as a complete structural model. If one had an infinite amount of data, it would be desirable to estimate the whole system simultaneously, but here, as in other structural macro-modeling contexts such as 'The Bank of England Quarterly Model' by Harrison, et al (2005), 'The Bank of England Macroeconomic Model' by Arestis and Swayer (2002) and 'A Model for Financial Programming' by Mikkelsen (1998), this is not feasible. Given our limited data span (which is, actually, long by the standards of most developing countries), one can identify a number of advantages of our equation-by-equation approach. The magnitude and significance of individual long-run parameters in each structural equation is of the interest per se in order to facilitate our understanding of the interaction of target and policy variables: estimating a single equation allows a much tighter focus on those parameters and their properties. The specification of each structural equation is theoretically motivated and the cointegrating vectors are identified a priori based on theory rather than having to be specified ad hoc to meet the demands of estimating as a system. In addition, the complete model includes a large number of identities (defined variables) which link the different sectors in the economy; if it were estimated simultaneously all these would have to be included.

On the other hand, one of the drawbacks of estimating single-equation ECMs is that the approach is built on the assumption that all explanatory variables are weakly exogenous. Particularly, since the model uses annual data, it is reasonable to suspect contemporaneous correlations. Banerjee (1998, p.274) states that the weak exogeneity assumption is fairly well used in practice and allows for the presence of lags of the dependent and explanatory variables in the data generation process of the ARDL conditional model. Durevall, et al (2013) argues that if the estimated coefficients are confirmed to be stable, we can use this fact as an indirect support for the use of single-equation ECMs.

3.6.3 Simulation Model

Section 3.5 set out the model by way of its long-run relationships, and now the estimation supplements these with quite complex dynamics along the lines of equation (49) above. The model is solved year-by-year recursively. All the estimated dynamic equations plus the necessary identities in the model are solved for each observation in the solution sample, using an iterative algorithm to compute values for the endogenous variables.

Using the model in a FP context requires that key policy objectives such as long-term growth, inflation and international reserve are set at target levels from outside the model and so are exogenous at the simulation stage. This is possible because the FP model determines the values of the two-gap variables – the foreign exchange gap and the fiscal gap – that render the target feasible. In the FP model, variables such as the interest rate, the reserve requirement ratio, the exchange rate and government consumption are also set exogenously for each simulation. It would be possible in principle, however, to set the gap variables to zero – so that the model is perfectly closed – and then find endogenously the values of the policy variables that permit this to occur.

3.6.4 Structure of the model

The model contains behavioral relations for potential output, private consumption and investment, infrastructure output, human capital, exports and import demand. Overall, the system consists 46 endogenous variables of which 7 behavioral variables and remaining 39 identities. Table 3.2 below provides summary of the structure of the model. Definitions of the variables are given in Table 3.3.

Table 3-2: The Basic Structure of the Model

Policy Targets	Endogenous Variables, determined in				Exogenous Variables		Policy Instruments	Parameters/ Coeff-icients
	Behavioural relationships	Identities						
g^T	I_p	Q^T	Π		N	R	e	α_{ij}
	X	I	Π^e		N_RUR_P	WFP	I_g_Q	β_{ij}
Π^T	Z	Ig	Ω_g		i^f	F_{mt-1}	C_g_Q	υ
	H	K	Ω		e^f	D_{mt-1}	rqr	σ
$\Delta F_m{}^T$	FQ	Kg	PD		PD^f	D_{bgt-1}	i	Θ_i
	C_p	Q	PD^T		T	F_{gt-1}	ΔD_{mg}	w_i
	M^D	m	Π^f		OIN	F_{t-1}	ΔF_m	
		RM	B		CC	B_{t-1}	ΔF_g	
		M^S	Y^d		SD	K_{t-1}	ΔB	
		EX_AD	F_m		TD	K_{gt-1}	ΔD_{bg}	
		REER	F		ED	PD_{t-1}	TX_Q	
		r	F_g		DD		NTX_Q	
		C_g	D_{bg}		Y_{ag}_Q			
		D_{mg}	cc		G_{cg}			
		PC_RUR OUT	sd		G_{kg}			
		S	td		G_{cp}			
		S_NTL	err		G_{kp}			
		S_I_NTL	TX		ΔF_p			
		S_FORG N	NTX		ΔF_b			
		S_I			W			

3.6.5 The Structure of the Model in Simultaneous Equations Form

This section pulls the model together and presents the simultaneous equation structure of the modified financial programming model that combines all the behavioral equations, identities and exogenous variables presented in the theoretical section (Section 3.5). The definitions of the variables are provided in Table 3.3 above. The precise model used in the

simulation and forecasting exercise, with all the identities and parameter values and lags as estimated in Section 3.7 below is presented in Annex I.

Table 3-3: Definitions of Variables

I. Endogenous Variables		II. Exogenous Variables	
Cg	real gov't consumption	β_{ij}	short-run elasticity coefficient
Cp	real private consumption	α_{ij}	long-run elasticity coefficient
D_{mg}	central bank's net claims on gov't	ΔF_b	change in NFA of commercial banks
FQ	infrastructure services (output)	ΔF_g	change in NFA of the government
F	total investment abroad	ΔF_m	change in NFA of the central bank
F_b	NFA of commercial banks	ΔF_p	change in NFA of the private sector
F_g	NFA of the government	B	total treasury bills holdings;
F_m^T	net international reserves target (F_m) in local currency	cc	currency in circulation ratio
F_p	NFA of the private sector	Cg_Q	real gov't consumption demand
H	Human capital stock	D_{bg}	Comm. banks' claims on gov't
I	gross total capital formation	e	nominal exchange rate
I_g	gross public capital formation (including state enterprises capital formation)	err	excess reserve ratio
I_p	total private capital formation	G_{cg}	external government current transfer;
K	total gross capital stock,	G_{cp}	external private transfers
K_g	gross public capital stock	G_{kg}	government net external borrowing
M	the money multiplier	G_{kp}	private net external borrowing
M_d_PD_A	real money demand	g^T	long-term growth rate (target)
MS	broad money supply (M2)	i	domestic nominal interest rate
NTX	total non-tax revenue	i^f	Foreign nominal interest rate
PC-RUROUT	per-capita rural output ratio;	I_g_Q	public capital formation to GDP ratio
Q	real GDP (aggregate demand)	N	labour stock measured by total population
Q^T	potential output	NTX_Q	non-tax revenue to GDP ratio

Table 3-3 (Cont'd): Definition of Variables

I. Endogenous Variables		II. Exogenous Variables	
R	real domestic interest rate;	OIN	Other items net (OIN) of the central bank;
REER	real effective exchange rate;	POPagr	rural population;
RM	reserve money of the central bank;	rqr	legal reserve ratio on bank deposits
S	gross domestic savings (domestic private plus public sector savings)	sd	saving deposits ratio
S_FORGN	foreign savings	td	time deposits ratio
S_I	saving-investment gap after available foreign savings	TX_Q	total tax revenue to GDP ratio
S_I_NTL	saving-investment gap before financing from available foreign savings	W	workers remittance
S_NTL	gross national savings	Y_{ag}_Q	agricultural output to GDP ratio
TX	total tax revenue	Θi	the weight attached to the contribution of channel 'i'
X	real exports of goods and services	σ	annual depreciation rate of capital stock
Y	real domestic disposable income;	Π	domestic inflation rate of consumer goods
Z	real imports of goods and services	WFP	food price index of major trading partner countries
Ω	BOPs financing gap	υ	the weight attached to the contribution of inflation target on people's formation of inflation expectation
Ω_g	government financing gap		
Π^T	domestic inflation rate		
Π^f	food inflation in major trading partner countries		
Π^e	inflation expectation		
PD	domestic price index		
PD^T	Domestic price index target		

A dynamic solution is used to predict the future values of the variable for the entire period of both within sample and out-of-sample simulations. E-views solves the model

recursively using an iterative procedure. The FP framework has seven blocks, i.e., the long-term growth and productivity; the aggregated demand; the money market; the government sector; the balance of payments; saving-investment equilibrium and price blocks.

I. Long-term Growth, Investment and Total Factor Productivity Block

I.A Long-Term Output Growth

$$Q_t^T - Q^T_{t-1}(1+g^T) = 0 \quad \ldots\ldots 1$$

I.B. Total Investment and Factor Productivity Growth

I.B.1. Total Capital Stock

$$K_t - [I_t + (1-\sigma)K_{t-1}] = 0 \quad \ldots\ldots 2$$

$$I_t - (I_{gt} + I_{pt}) = 0 \quad \ldots\ldots 3$$

$$K_{gt} - (1-\sigma)K_{gt-1} + I_{gt} = 0 \quad \ldots\ldots 4$$

I.B.2. Total Private Investment Requirement

$$I_{pt} - [(g^T - [\alpha_{13}\Delta\ln N_t + \alpha_{14}\Delta\ln H_t + \alpha_{15}\Delta\ln FQ_t + \alpha_{16}\Delta\ln X_t])K_{t-1}/\alpha_{12} - I_{gt} + \sigma K_{t-1}] = 0 \quad \ldots\ldots 5$$

I.B.3. Total Factor Productivity Growth

$$\Delta\ln H_t - [\sum\beta_{21}\Delta\ln H_{t-m} + \sum\beta_{22}\Delta\ln K_{gt-m} + \sum\beta_{23}\Delta\ln(Q/N)_{t-m} + \alpha_{21}(\ln H_{t-1} + \alpha_{22}\ln K_{gt-1} + \alpha_{23}\ln(Q/N)_{t-1} + \alpha_{24})] = 0 \quad \ldots\ldots 6$$

$$\Delta\ln FQ_t - [\sum\beta_{31}\Delta\ln FQ_{t-m} + \sum\beta_{32}\Delta\ln K_{gt-m} + \sum\beta_{33}\Delta\ln NL_{t-m} + \alpha_{31}(\ln FQ_{t-1} + \alpha_{32}\ln K_{gt-1} + \alpha_{33}\ln NL_{t-1} + \alpha_{34})] = 0 \quad \ldots\ldots 7$$

$$\Delta\ln X_t - [\sum\beta_{41}\Delta\ln X_{t-m} + \sum\beta_{42}\Delta\ln Q_{t-m} + \sum\beta_{43}\Delta\ln REER_{t-m} + \alpha_{41}(\ln X_{t-1} + \alpha_{42}\ln Q_{t-1} + \alpha_{43}\ln REER_{t-1} + \alpha_{44})] = 0 \quad \ldots\ldots 8$$

$$REER_t = \sum w_{it}(e^f_{it}/e_t)(PD^f_i/_t PD_t) \quad \ldots\ldots 9$$

II. Short-Term Aggregate Demand

$$Q_t - C_{pt} - C_{gt} - I_{pt} - I_{gt} - X_t + Z_t = 0 \quad \ldots\ldots 10$$

$$\Delta\ln C_{pt} - [\sum\beta_{51}\Delta\ln C_{pt-m} + \sum\beta_{52}\Delta\ln Y^d_{t-m} + \sum\beta_{53}\Delta r_{t-m} + \alpha_{51}(\ln C_{pt-1} + \alpha_{52}\ln Y^d_{t-1} + \alpha_{53}r_{t-1} + \alpha_{54})] = 0 \quad \ldots\ldots 11$$

$$Y^d_t - (Q_t - T_t) = 0 \quad \ldots\ldots 12$$

$$r_t - (1+i_t)/(1+\Pi_t) = 0 \quad \ldots\ldots 13$$

$$C_{gt} - C_g\_Q^K{}_t * Q_t = 0 \quad \ldots\ldots 14$$

$\Delta \ln Z_t - [\sum \beta_{61} \Delta \ln Z_{t-m} + \sum \beta_{62} \Delta \ln Q_{t-m} + \alpha_{61} (\ln Z_t + \alpha_{62} \ln Q_t + \alpha_{63})] = 0$ 15

III. The Money Market

III.A Money Supply

$M^S_t - m_t * RM_t = 0$ 16

$RM_t - (e_t * F_{mt} + D_{mg}{}^K_t - OIN^K_t) = 0$ 17

$F_{mt} - (F_{mt-1} + \Delta F_m{}^K_t) = 0$ 18

$D_{mgt} - (D_{mgt-1} + \Delta D_{mg}{}^K_t) = 0$ 19

$m_t - (1+cc_t)/[rqr_t (1+sd_t+td_t)+cc_t+err_t] = 0$ 20

$cc_t - CC^K_t/DD^K_t = 0$ 21

$sd_t - SD^K_t/DD^K_t = 0$ 22

$td_t - TD^K_t/DD^K_t = 0$ 23

$ed_t - ED^K_t/DD^K_t = 0$ 24

III.B Money Demand

$\Delta \ln(M^D/PD)_t - [\sum \beta_{71} \Delta \ln(M^D/PD)_{t-m-1} + \sum \beta_{72} \Delta \ln Y^d_{t-m} + \sum \beta_{73} \Delta \ln PC\text{-}RUROUT_{t-m} + \sum \beta_{74} \Delta r_{t-m} + \sum \beta_{75} \Delta \ln REER_{t-m} + \alpha_{71}[(\ln(M^D/PD)_{t-1} + \alpha_{72} \ln Y^d_{t-1} + \alpha_{73} \ln PC\text{-}RUROUT_{t-1} + \alpha_{74} \Delta r_{t-1} + \alpha_{75} \ln REER_{t-1} + \alpha_{76}]] = 0$ 25

$PC\text{-}RUROUT_t - Y_{ag}\_Q^K{}_t * Q_t / N\_RUR\_P_t = 0$ 26

III.C Money Market Equilibrium

$M^S_t - M^D_t = 0$ 27

IV The Government Sector

$\Omega_{gt} - [(TX_t + NTX_t + G_{cg}{}^K_t + G_{kg}{}^K_t) - [C_{gt} + I_{gt} + e_t * i_t^f * F_{gt} + i_t * (D_{mgt} + D_{bgt} + B_t)] + (e_t * \Delta F_g{}^K_t + \Delta D_{bg}{}^K_t + \Delta D_{mg}{}^K_t + \Delta B^K_t)] = 0$ 28

$TX_t - TX\_Q^K{}_t * Q_t = 0$ 29

$NTX_t - NTX\_Q_t * Q_t = 0$ 30

$F_{gt} = F_{gt-1} + \Delta F_g{}^K_t$ 31

$D_{bgt} = D_{bgt-1} + \Delta D_{bg}{}^K_t$ 32

$B_t = B_{t-1} + \Delta B^K_t$ 33

V. The Balance of Payments

$\Omega_t - [(PD * X/e)_t - (PD * Z/e)_t + i^f F_t + W^K_t + G_{cp}{}^K_t + G_{cg}{}^K_t + G_{kp}{}^K_t + G_{kg}{}^K_t$

$-\Delta F_m{}^K{}_t-\Delta F_g{}^K{}_t-\Delta F_b{}^K{}_t-\Delta F_p{}^K{}_t]= 0$…….……..……..…….…... 34

$F_t = F_{t-1} + \Delta F_{mt} + \Delta F_g{}^K{}_t + \Delta F_b{}^K{}_t + \Delta F_p{}^K{}_t$…….……..…… 35

VI. Saving-Investment Equilibrium

VI.A Domestic Savings

$S_t- [\Delta K_t + (X_t-Z_t)] = 0$ ……..……..…… 36

VI.B National Savings

$S\_NTL_t \ -[\Delta K_t + (X_t - Z_t) + e_t*(i^f{}_tF_t + W^K{}_t + G_{cp}{}^K{}_t + G_{cg}{}^K{}_t)] = 0$ ..……..…… 37

VI.C Saving –Investment Gap

$S\_I\_NTL_t \ - [S\_NTL_t \ - \Delta K_t] \ = 0$ ……..……..……..…….…... 38

VI.D Available Foreign Savings

$S\_FORGN_t – e_t*[G_{kp}{}^K{}_t+ G_{kg}{}^K{}_t-\Delta F_m{}^K{}_t-\Delta F_g{}^K{}_t-\Delta F_b{}^K{}_t-\Delta F_p{}^K{}_t] = 0$……..…..……39

VI.E Saving-Investment Gap after Available Foreign Financing

$S\_I_t \ - [S\_I\_NTL_t \ + S\_FORGN_t] = 0$ ……..…….……..…… 40

VII. Aggregate Supply and Prices

$\Pi_t- (\Theta_1 EX\_AD_t + \Theta_2\Pi^f{}_t+ \Theta_3\Pi^e{}_t) = 0$ ……..……..……..……..…… 41

$EX\_AD_t - (M^S{}_t - M^d{}_t)/ M^d{}_t = 0$ ……..……..……..…….. 42

$\Pi^f{}_t- [(WPF_t - WPF_{t-1}) / WPF_{t-1}] \ = 0$ ……..…..…….……..…….. 43

$\Pi^e{}_t - [\upsilon [(PD^T{}_t/PD^T{}_{t-1})-1] + (1-\upsilon)* [(PD_{t-1}/PD_{t-2})-1]] = 0$ ……..…….. 44

$PD_t- (1+ \Pi_t) PD_{t-1} = 0$ ……..……..……..…… 45’

3.7 Estimation Results of Individual Equations

This section reports the estimation of the long-run equations specified in Section 3.5. The estimation takes a short-run dynamic error correction mechanism as presented in equation (49). Except for the real interest rate, which enters as explanatory variable in the private consumption function (equation 11) and the nominal interest rate in the demand for money function (equation 25), all variables are transformed into natural logarithms. Interest rates are expressed in percentage form. This all implies that, except in the case of interest rate, all other reported coefficients are elasiticities. We do not have much theory with which to interpret the short-run dynamics, so we do not spend much time describing them, but we do note a few striking features below. The long-run coefficients of the ARDL model, on the

other hand, are of keen interest because we can interpret them and because financial programming is basically a long-run exercise.

The estimates of the long-run relationships are shown in bold in square brackets below and will form the center of our discussion in this section. Following the literature, the coefficients inside the bracket are normalized by dividing the estimated long-run coefficients by the ECM term, i.e. α_1 as illustrated under equation (49) [Pesaran and Shin, 1997 and Banerjee, et al, 1998]. A key estimate is that of α_1, the error correction mechanism (ECM) coefficient, the sign and significance of which tells us whether the long-run estimates represent a genuine long-run cointegrated relationship or not. It needs to be significantly less than zero for cointegration, so that if, say, the actual value of the dependent variable exceeds the predicted long-run value, the growth of the variable is reduced in the next period. The significance of these coefficients are tested using the Pesaran et al, (2001) bound test statistic with unrestricted intercept and no trend. The Pesaran et al, (2001) critical values for the bound test statistics are attached as Annex VII and VIII on pages 259-261.

3.7.1 Potential Output

Equation (50) reports the long-run growth or potential growth model specified in equation (1'). The estimation result shows that the ECM term is significant at one percent level as reflected by a t-statistic of -6.62. The critical value at one percent level of significance with three period lag is -4.37. All the coefficients in the long-run model have the expected signs.

The elasticity of output with respect to physical capital is 0.53 which implies a 1 percent increase in capital stock expands potential output by 0.53 percent which is moderately higher than the other developing countries which about 0.40 percent when structural factors such as export growth and human capital (education) are included [Chenery, 1986]. The higher elasticity in Ethiopia might reflect the fact that initial capital stock was lower than the average in developing countries [Romer, 2006 and Agenor and Montiel, 1999]. Labor is found to be insignificant, as expected in a typical labor surplus agrarian economy. On

the other hand, human capital, infrastructure services and exports are all found to have significant positive contributions to economic growth, via the spillover they induce, with elasticities of 0.15, 0.13 and 0.08 respectively. The sum of elasticities of all production inputs in equation (50) is about 0.94, which is close to constant returns to scale. This supports the argument by Agenor and Montiel (1999, p.680) that "… in models exhibiting spillover effects sustained growth does not result from the existence of external effects, but rather from the assumption of constant returns to scale in all production inputs that can be accumulated"[84].

The ECM coefficient is 0.72, which suggests that long-run disequilibria in potential output are corrected quickly. This is not surprising given that equation (1') is close to being a technological rather than a behavioral relationship. This rapid adjustment is overlaid, however, by cyclical dynamics, which suggest that increases in Q are partially unwound after two years (negative coefficients on lagged values) and a very strong instantaneous reaction to physical capital, which is gradually eroded through the error correction mechanism, and the dynamics of Q.

$$\Delta LOG(Q) = \underset{(-2.5745)}{-0.1835}*\Delta LOG(QP(-2)) \underset{(-1.3276)}{- 0.1060}*\Delta LOG(Q(-3)) \underset{(2.8522)}{+ 1.7198}*\Delta LOG(K)$$

$$\underset{(1.8319)}{+ 0.1966}*\Delta LOG(N_T) \underset{(-4.2285)}{- 0.4084}*\Delta LOG(N_T(-1)) \underset{(-5.8901)}{- 0.5695}*\Delta LOG(N_T(-2))$$

$$\underset{(-4.3106)}{- 0.4393}*\Delta LOG(N_T(-3)) \underset{(1.7836)}{+ 0.0565}*\Delta LOG(H) \underset{(-2.6250)}{- 0.1408}*\Delta LOG(FQ(-2))$$

$$\underset{(-5.5762)}{- 0.2632}*\Delta LOG(FQ(-3)) \underset{(2.5209)}{+ 0.0681}*\Delta LOG(X) \underset{(-3.2619)}{- 0.0694}*\Delta D(LOG(X(-1))$$

$$\underset{(2.3160)}{+ 0.0494}*\Delta LOG(X(-3)) \mathbf{- \underset{(-6.6282)}{0.7175}*[LOG(Q(-1)) \underset{(-2.1930)}{- 0.5325}*LOG(K(-1))}$$

$$\mathbf{+ \underset{(-0.4996)}{0.0374}*LOG(N_T(-1)) \underset{(-4.0342)}{- 0.1497}*LOG(H(-1)) \underset{(-2.0410)}{- 0.1227}*LOG(FQ(-1))}$$

$$\mathbf{\underset{(-5.4832)}{- 0.0171}*DSB2007*LOG(FQ(-1)) \underset{(-2.2806)}{- 0.0805}*LOG(X(-1)) \underset{(1.5156)}{+ 0.0519}*DUMY92 \underset{(-1.1801)}{- 2.6043}] \quad \ldots\ldots\ldots\ldots 50}$$

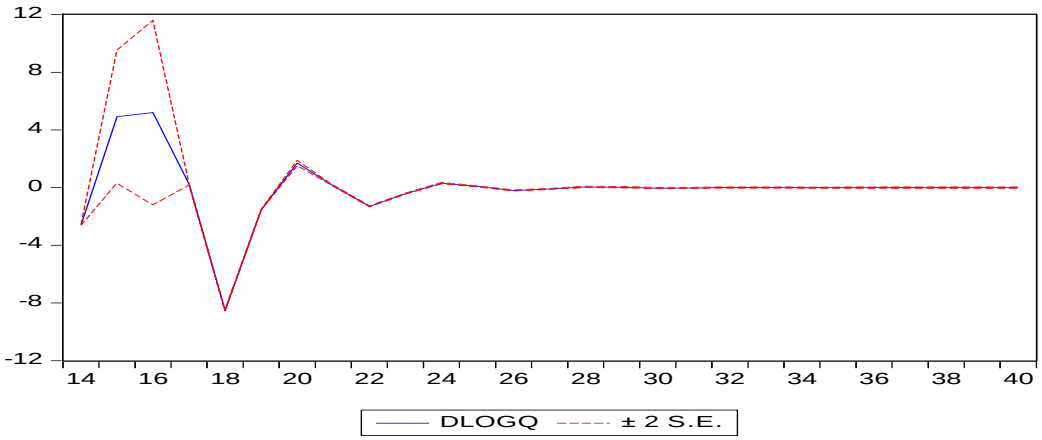
$$\text{Adjusted}R^2 = 0.967 \quad s = 0.017$$

[84]Robelo (1991) also emphasizes that increasing returns are neither necessary nor sufficient to generate endogenous growth.

Figure 3.3 shows the impulse response function for a onetime 10 percent increase in physical capital. The figure demonstrates that the model is stable but that adjustment takes a relatively long time to settle to the steady-state value. There are also vigorous dynamics associated with changes in the labor force, but given that the variable itself evolves very steadily, these do not end up having much impact on the temporal evolution of Q.

As we discuss below, however, the diagnostic tests indicate the need for a permanent shock to output of five percent in 1992 as the economy was liberalized and also a structural change in the relationship with at least one of the regressors in fiscal year

Figure 3-2: Impulse response of output (Q) for a 10 percent increase in physical capital stock (K) in 2014

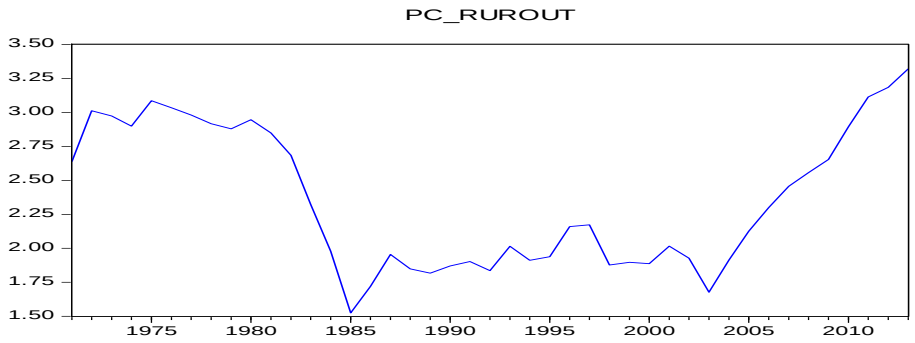


2007. The change in 2006 and 2007 is attributed to a significant shift in food markets, which accounted for about 57 percent of the consumption basket. For the first time since the country began to compile official statistics, food inflation began to be positive during a good harvest season (i.e., between November and January), outside drought and war years. We discuss food inflation below, but, briefly, Figures 3.13 and 3.14, on pages 149, depict quarterly food inflation line-graphs for the periods 1981-2006 and 2007-2013, respectively. The graph in the second period clearly shows that inflation stayed positive throughout the period, with very few exceptions.

As argued in Chapter 2, the change in the structure of the food markets, and the resulting break in the food inflation cycle, stems from years of investments in rural telecommunication and road infrastructure, which facilitated the integration of people in

rural areas into telecom and transport services. Moreover, better access to rural credit through microfinance institutions has eased liquidity constraint in rural areas. Todaro and Smith (2009, p.237) argue, "Raising the income levels of the poor will stimulate an overall increase in the demand for locally produced necessity products like food and clothing, whereas the rich tend to spend more of their additional incomes on imported luxury goods". As illustrated in Figure 3.2 below, per capita rural income has steadily risen since 2004, but in value terms, it took almost three years, until 2006, to reach the level attained in 1996.

Figure 3-3: Annual Real Per-capita Rural Income (1971-2013) in thousand Birr



It is not possible to estimate the equation in standardized form but we can calculate the relative contributions to potential output by calculating the effects of increasing each variable by a 'typical amount'. Table 3.4 shows the contributions implied by the long-run coefficients in terms of two 'typical variations' – the standard deviation of each variable which, broadly, captures how much statistical explanation each variable offers, and the average growth of each variable over my sample, which gives a more historically oriented view. Table 3.4 presents a calculation of the former type.

Table 3-4: Contribution of Each Variable to Output Growth

Variable	lnQ	lnK	lnN	lnH	lnFQ	lnX	Sum/ Residual
Coefficient	1.000	0.533	0.037	0.150	0.140	0.081	
Std. Deviation	0.108	0.174	0.054	0.027	0.023	0.025	
Contribution	0.108	0.093	0.002	0.004	0.003	0.002	0.104
Shares		85.7%	1.9%	3.7%	3.0%	1.9%	3.9%

Table 3.4 indicates that Ethiopia's economic growth is highly dependent on physical capital formation over the sample period (1971-2013)[85]. In China, Wang and Yao (2002), using a simple growth-accounting framework that incorporates human capital stock, found that physical capital contributed about 47.7 percent of China's economic growth during reform period (1978-1999), while labor, human capital stock and the residual TFP contributed 15.9 percent, 11.0 percent and 25.4 percent, respectively. Moreover, for three newly industrialized economies, namely, Korea, Taiwan and Hong Kong, Young (1995) estimates that the contribution of total factor productivity ranges between 16.5 percent and 31.5 percent.

The findings have significant policy implication for Ethiopia. First, as the economy grows, the marginal cost of keeping the current growth momentum though physical capital accumulation rises significantly, which would raise the question of financing. Second, as the cost of investment grows, the country becomes less competitive in the international market, which in turn, worsens the current account situation. Hence, Ethiopia needs to strengthen further its policies on raising total factor productivity as well as investing strongly in human capital development and infrastructure growth.

A. Diagnostic tests

The reported robustness test statistics are in table 3.5 below.

Table 3-5: Diagnostic test results

Tests	Jarque-Bera	ARCH	RESET	LM
Statistic	0.142	0.57	10.158	1.97
p-values	(0.93)	(0.448)	(0.001)	(0.37)

Briefly, they suggest the following:

[85]The results may have been heavily influenced by the economic situation during the period between 1971 and 2003, which accounts about three-fourths of the total sample. During that period, average unemployment was more than 30 percent, export growth was depressed, and the country did little on human capital and infrastructure development. On the other hand, between 2004 and 2013, government has made significant investment on human capital and infrastructure developments. So, the picture is expected to be different in the latter period. However, the small sample size limits me from running a separate regression for the period.

1/The model passes Breusch-Godfrey Serial Correlation LM test. The null hypothesis of no autocorrelation cannot be rejected.
2/The null hypothesis of normally distributed errors, the Jarque-Bera test, is not rejected, which indicates that inference about the coefficients is likely to be correct.

3/In the LM test for autoregressive conditional heteroscedasticity (ARCH), the null hypothesis of homoscedasticity cannot be rejected, which offers some comfort about omitted variables and suggests that the standard errors are efficiently estimated.

4/ In the RESET test, the null hypothesis is that the functional form is correct and the value of the test statistic greater than the Chi-squared critical value rejects the null. This test has been criticized for being oversized in ADL models with I (1) variables leading to frequent over-rejections, however: based on a Monte Carlo experiment on the validity of diagnostic tests, Gerrard and Godfrey (1998, p. 228) suggest extreme caution in interpreting its results.

B. Stability tests

Structural break tests were also conducted on the model before all the other diagnostic tests on the residuals and the parameters were carried out. As the Chow break point test is found unsuitable to equation (50) because of the presence of a step dummy in 1992, the approach described in section 3.6.2.3 is used.

Table 3.6 presents the long run part of the estimated potential output model Equation (1') in ECM form three possible structural shifts - starting respectively in 2000, 2004 and 2007. These dates are selected based on a prior knowledge[86]. The year 2000 is the period when the Ethiopian government started to give special emphasis to economic growth following the end of the two-year border conflict with Eritrea, while 2004 is the year in which the country embarked on a double-digit growth path. On the other hand, in connection with the Ethiopian millennia[87], several road and water projects and one of the largest hydroelectric power dams were commissioned in the year 2007. In addition, 2007

[86]In addition, visual inspection of trends of fitted and residual plots are also used as supplementary evidences. For instance, the residual plot shows a strong upward shift in 2007 and the model's predictive power gets weaker since then.
[87]The Ethiopian millennium, i.e. 2000 E.C., was celebrated on September 11, 2007.

was the year when government renewed its commitment to Ethiopian renaissance and called for national reconciliation. As a result, at the government's invitation, a record number of Ethiopian Diaspora returned home and began to be engaged in a wide range of investment activities in the country.

Table 3.6 shows that, based on a t-test on the structural shift variable[88] [DSB(2007)*LogFQ(-1)], there is strong evidence for the presence of a structural shift in the relationship between output and infrastructure starting 2007[89]. The results also clearly show that the inclusion of a structural shift variable improves the overall performance of the model. For instance, unlike the other models, the coefficient of the lagged long-run output variable (Log(Q(-1)), which is also the ECM term, is found significant at 1 percent level. In the other models, the ECM term fails to pass even at 10 percent significance level. Moreover, physical capital, infrastructure output and exports are also found to be significant with a shift in 2007, whereas they generally failed to be so in the remaining models.

Table 3-6: Tests for structural break point in potential output equation

	2000		2004		2007	
Long-run variable1/	Coeffi-cient	t-ratio	Coeffi-cient	t-ratio	Coeffi-cient	t-ratio
Log K(-1)	0.400	1.352	0.291	0.962	0.382	2.193**
Log N_T(-1)	-0.071	-0.561	-0.053	-0.561	-0.027	-0.500
Log H(-1)	0.104	2.313**	0.091	2.033*	0.107	4.034***
Log FQ(-1)	0.058	0.475	0.052	0.693	0.088	2.041*
Log X(-1)	0.014	0.331	0.012	0.322	0.058	2.281***
Log Q(-1)	-0.518	-3.038	-0.449	-2.494	-0.717	-6.628***
DSB(X)*LogFQ(-1)	0.001	0.182	0.003	0.916	0.012	5.483***

1/DSB(X) represents DSB2000, DSB2004 andDSB2007 respectively, where DSB stands for dummy for structural break.

[88]The structural break tests were conducted on both human development (H) and infrastructure output (FQ) variables. However, based on t-test results and comparisons on the performance of the model, including the significance of the ECM term (in the three models), all the evidences indicate that the shift in infrastructure output variable is the prime cause for structural shift in the long run output model. Hence, the three models are re-estimated dropping the structural shirt variable attached to human development index variable [DSB(X)*LogH(-1)].

[89] According to the t-test results, there is no evidence of structural shift in the output equation in 2000 and 2004.

The cumulative sum of recursive residual (CUSUM) and squares of recursive (CUSUMSQ) plots indicate that, once we allow for the structural break in 2007, the estimated coefficients are stable. The diagnostic figures are reproduced here for this case by way of illustration, but for the various equations below, I reproduce them only when the null hypothesis of stability is (nearly) rejected. In the case of potential output, the CUSUM and CUSUMSQ plots both remain within a 5 percent

Figure 3-4: CUSUM: 1971–2006

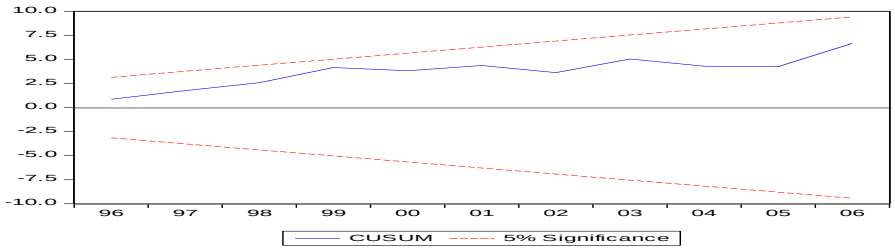


Figure 3-5: CUSUM: 2007–2013

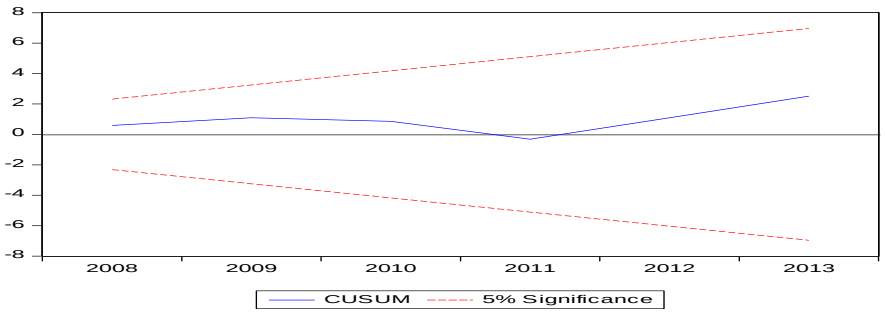


Figure 3-6: CUSUMSQ: 1971-2006

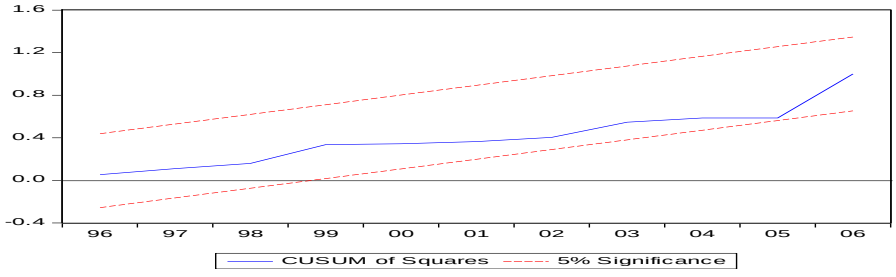
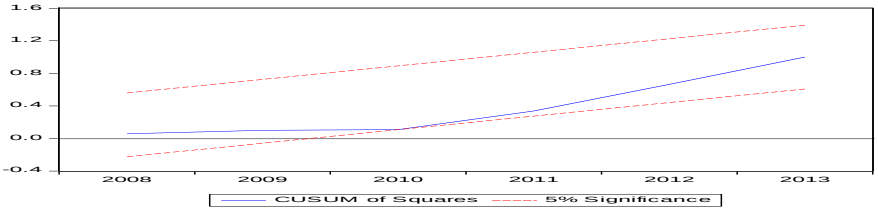


Figure 3-7: CUSUMSQ: 2007-2013



significance level portrayed by the two broken straight lines. However, note that because of the structural change built into final equation E-Views provides the tests only for subsets either side of the break.

3.7.2 Human Capital Development

Equation (51) reports the short-run dynamic error-correction model results of human capital model in equation (6). The ECM term is significant at one percent level confirming long-run relationship in the model, and its magnitude is about -0.9. As expected the elasticity of public physical capital stock is almost unity and is significant at one percent level implying a one-to-one relationship between public investment and human capital development.

$$\Delta LOG(H)) = \underset{(1.281)}{0.129}*\Delta LOG(H(-2)) + \underset{(3.844)}{0.376}*\Delta LOG(H(-3)) + \underset{(1.674)}{0.157}*\Delta LOG(H(-4))$$

$$+ \underset{(2.899)}{0.261}*\Delta LOG(H(-5)) + \underset{(0.934)}{0.166}*\Delta LOG(PC\_Y) - \underset{(-0.670)}{0.139}*\Delta LOG(PC\_Y(-1))$$

$$- \underset{(-1.987)}{0.362}*\Delta LOG(PC\_Y(-5)) + \underset{(4.917)}{2.689}*\Delta LOG(KG) + \underset{(2.000)}{1.215}*\Delta LOG(KG(-2)) +$$

$$\underset{(1.492)}{0.864}*\Delta LOG(KG(-5))\ \boldsymbol{-\ \underset{(-6.898)}{0.879}*[LOG(H(-1))\ -\underset{(-3.654)}{0.254}*LOG(PC\_Y(-1))}$$

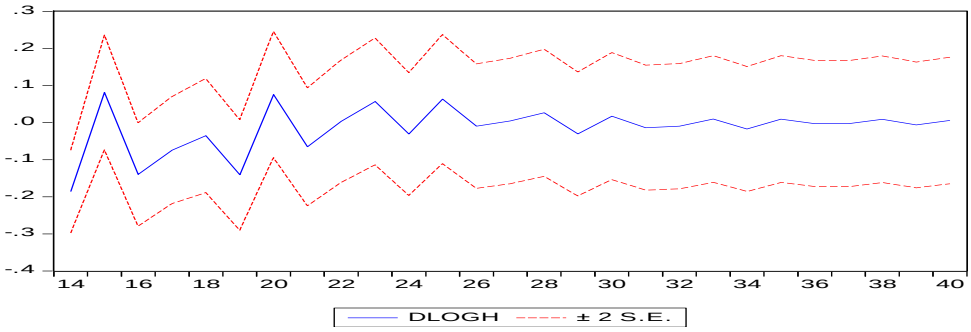
$$\boldsymbol{-\underset{(-6.356)}{1.121}*LOG(KG(-1)) + \underset{(6.162)}{9.148}]} \quad \ldots\ldots\ldots\ldots \quad 51$$

AdjustedR^2 = 0.684   s = 0.056

The estimated elasticity of per-capita income is about 0.25. In one sense this might reflect the incentive to families or individuals to invest human capital development, but it more probably reflects their capacity to finance education, which involves opportunity costs even if not direct costs. It is rather lower than one would expect because we tend to think of education as a superior good or service, however, increasing income arguably takes longer to work through the system to affect enrollment rates than just the immediate impact we have been able to identify here.

Figure 3.8 shows the dynamic adjustment to a 40 percent increase in public capital formation in 2015[90]. The variable reverberates around its steady-state for a longer time before it settles down.

Figure 3-8: Impulse response function for a 40 percent increase in public capital formation (I_g)



Equation (51) was subjected to the array of diagnostic and stability tests and revealed no concerns in any of them. The diagnostic tests are reported in Table 3.7 below

Table 3-7: Diagnostic Test results

Tests	Jarque_Bera	ARCH	RESET	LM
Statistic	0.432	1.462	1.162	0.676
p-values	(0.806)	(0.227)	(0.281)	(0.713)

3.7.3 Public Infrastructure

Equation (52) reports the ECM model estimation results of equation (7). The model confirms the presence of strong co-integration. The ECM term is significant at 1 percent level and its magnitude is close to 0.86. The Chow test confirmed presence of a structural break in the relationship between capital stock and infrastructure in 2000.[91] The sum of the elasticities of public capital stock indicate that, since 2000, a one percent increase in the

[90] A 40 percent increase in public capital formation (I_g) in 2015 is equivalent to adding an extra 3.3 percent to the public capital stock.

[91] As there is no step dummy in this model, a Chow break point test is applied to detect presence of a structural break.

former leads to a 0.83 percent increase in infrastructure output. In this equation, labor is also found to be insignificant. This implies that labor is not a major constraint on provision of infrastructural services in a labor-surplus economy like Ethiopia. Infrastructure sector mainly employs low-skilled workers.

$$\Delta LOG(FQ)) = \underset{(3.298)}{0.463}*\Delta LOG(FQ(-1)) + \underset{(2.548)}{0.360}*\Delta LOG(FQ(-2)) + \underset{(1.510)}{0.196}*\Delta LOG(FQ(-3))$$

$$+ \underset{(1.249)}{0.168}*\Delta LOG(FQ(-4)) + \underset{(2.866)}{1.698}*\Delta LOG(KG) - \underset{(-1.717)}{1.085}*\Delta LOG(KG(-1))$$

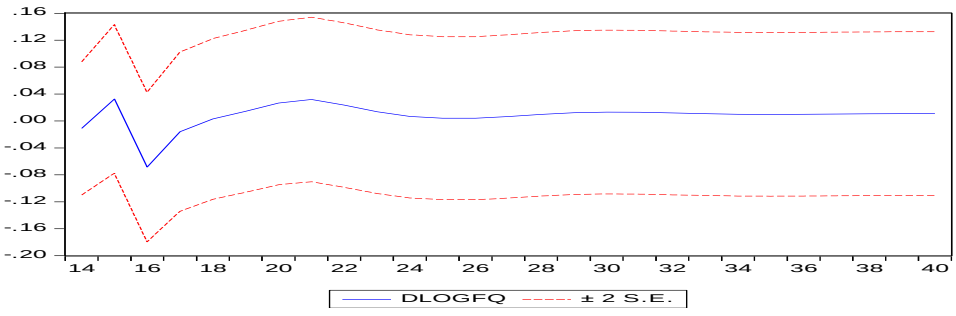
$$- \underset{(-1.049)}{0.505}*\Delta LOG(KG(-4)) + \underset{(2.356)}{0.368}\Delta LOG(N) \mathbf{- \underset{(-6.008)}{0.856}*[LOG(FQ(-1)) - \underset{(-5.047)}{0.802}*LOG(KG(-1)}}$$

$$\mathbf{\underset{(-5.976)}{-0.027}*DSB2000*LOG(KG(-1) \underset{(-0.626)}{-0.088}*LOG(N(-1) + \underset{(-3.824)}{1.998}]} \quad \text{52}$$

Adjusted $R^2 = 0.720$ s = 0.052

The short-term dynamics are quite long-lived in this equation. An increase in infrastructure services provision induces further increases in each of the next four years, while an increase in public investment produces a burst of infrastructure services, which then erodes over the next few years. Figure 3.9 shows the impulse response function for a 40 percent increase in public capital formation in 2015.

Figure 3-9: Impulse response function for a 40 percent increase in public capital formation



The equation passes the normality, heteroscedasticty, omitted variable and autocorrelation tests – see Table 3.8. The CUSUM and CUSUMSQ tests revealed a structural instability, which we identified as being in 2000, due to a shift in government policy towards public infrastructure investment. Once this is allowed for these tests, suggest no problems at all.

Table 3-8: Diagnostic Test results

Tests	Jarque_Bera	ARCH	RESET	LM	Chow Breakpoint Test (2000)
Statistic	2.719	0.096	0.002	1.195	96.36
p-values	(0.257)	(0.757)	(0.961)	(0.550)	(0.000)

3.7.4 Exports

In equation 53, the significance of the ECM term at 1 percent level signifies the presence of cointegration vector in the export equation. The speed of adjustment is relatively quick, suggesting that about four-fifth of the deviation from the long-run equilibrium will be eliminated the next year. Given the sensitivity of Ethiopia's economy to foreign exchange crises, this quick rate of adjustment is good news for economic management. Real GDP and the REER have the expected signs and both have long-run elasticities of around unity. The former is pretty much in line with experience elsewhere, but the latter is rather higher than found in most developing

$$\Delta LOG(X) = 0.268*\Delta LOG(X(-1)) + 0.300*\Delta LOG(X(-2)) + 0.419*\Delta LOG(X(-3))$$
$$(1.559) \qquad (1.623) \qquad (2.234)$$

$$+ 0.296*\Delta LOG(X(-4)) - 0.480*\Delta LOG(REER) + 0.306*\Delta LOG(REER(-2))$$
$$(1.828) \qquad (-2.829) \qquad (1.286)$$

$$+ 0.616*\Delta LOG(REER(-3)) + 0.316*\Delta LOG(REER(-4)) + 1.100*\Delta LOG(Q)$$
$$(3.059) \qquad (1.349) \qquad (2.328)$$

$$- 1.311*\Delta LOG(Q(-1)) - 0.455*\Delta LOG(Q(-4)) \mathbf{- 0.783*[LOG(X(-1))}$$
$$(-2.574) \qquad (-0.925) \qquad \mathbf{(-4.360)}$$

$$\mathbf{+ 0.670*LOG(REER(-1)) - 1.205*LOG(Q(-1)) - 0.531*DUMMY\_84}$$
$$\mathbf{(4.192) \qquad (-4.293) \qquad (-3.144)}$$

$$\mathbf{+ 0.561*DUMY92 + 1.489]} \quad (53)$$
$$\mathbf{(3.313) \qquad (0.895)}$$

Adjusted $R^2 = 0.725$ s = 0.107

countries. Although adjustment may be quite slow, this strong response to the real exchange rate suggests that the Ethiopian government is fortunate in terms of having an

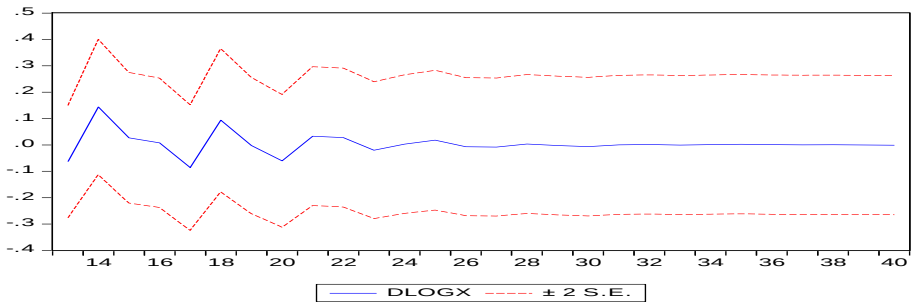
effective tool with which to manage its balance of payments. The dynamic adjustment of exports to 10 percent increase in real GDP is illustrated in figure 3.10.

The export equation passes all the diagnostic tests Table 3.9 and the CUSUM and CUSUMSQ tests also confirm that the estimated equation is very stable. The step dummies for 1984 and 1992 are needed to make the model stable. The former represents the most severe drought that caused agricultural output to decline by 13 percent while the latter stands for change of government.

Table 3-9: Diagnostic Test Results

Tests	Jarque_Bera	ARCH	RESET	LM
Statistic	0.570	2.298	0.703	0.516
p-values	(0.752)	(0.131)	(0.402)	(0.773)

Figure 3-10: Impulse response function for a 10 percent increase in real GDP (Q) in 2014



3.7.5 Private Consumption

The private consumption function is also found to have a stable long-run relationship with an ECM close to 0.8. The long-run elasticity of consumption with respect to disposable income is close to one in line as one might expect in a poor economy. As expected, the real interest rate negatively affects private consumption demand, with a partial elasticity that implies that a one-percentage point increase in real interest rate leads to a 0.002 percent decrease in private consumption demand.

$$\Delta LOG(CP) = -0.180*\Delta LOG(CP(-1)) + 0.123*\Delta LOG(CP(-4)) + 0.603*\Delta LOG(YDI)$$
$$(-1.375) \qquad (0.686) \qquad (5.373)$$

$$+ 0.001*\Delta RINTRATE(-1) + 0.001*\Delta RINTRATE(-2) \mathbf{- 0.782*[LOG(CP(-1))}$$
$$(1.555) \qquad (0.810) \qquad \mathbf{(-4.834)}$$

$$\mathbf{-1.080*LOG(YDI(-1)) + 0.002*RINTRATE(-1) + 1.242]} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 54$$
$$\mathbf{(-5.107) \qquad (2.120) \qquad (4.421)}$$

Adjusted $R^2 = 0.734$ s = 0.034

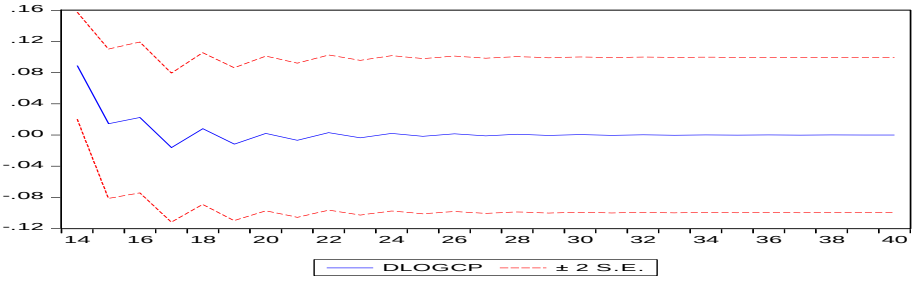
The model settles into its steady state value relatively quickly– see figure 3.11 for the impulse response function.

As with other equations, the diagnostic tests are all passed with very little sign that the null hypotheses of 'good' behavior are rejected – Table 3.10.Likewise, there is no sign of instability.

Table 3-10: Diagnostic Test Results

Tests	Jarque-Bera	ARCH	RESET	LM
Statistic	0.515	0.012	0.573	1.562
p-values	(0.773)	(0.912)	(0.449)	(0.458)

Figure 3-11: Impulse response function for a 10 percent increase in real YDI in 2014



3.7.6 Imports

The import function is found to be subject to repeated structural shifts. The first one happens in 1993 when the country liberalized trade from a command economy supported by the IMF and the World Bank. The second structural break happened in 2004 when the economy shifted to double digit growth trajectory.

$$\Delta LOG(Z) = 0.153*\Delta LOG(Z(-2)) + 0.165*\Delta LOG(Z(-4)) - 1.627*\Delta LOG(Q(-2))$$
$$(1.146) \qquad (1.171) \qquad (-3.591)$$

$$- 0.824*\Delta LOG(Q(-4)) \mathbf{- 0.338*[LOG(Z(-1)) -0.992*LOG(Q(-1))}$$
$$(-1.686) \qquad \mathbf{(-4.027)} \qquad \mathbf{(-1.960)}$$

$$\mathbf{-0.080*DSB1993*LOG(Q(-1)) -0.057*DSB2004*LOG(Q(-1)) + 1.897]} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 55$$
$$\mathbf{(-5.333)} \qquad \mathbf{(-3.102)} \qquad \mathbf{(0.420)}$$

Adjusted $R^2 = 0.607$ s = 0.094

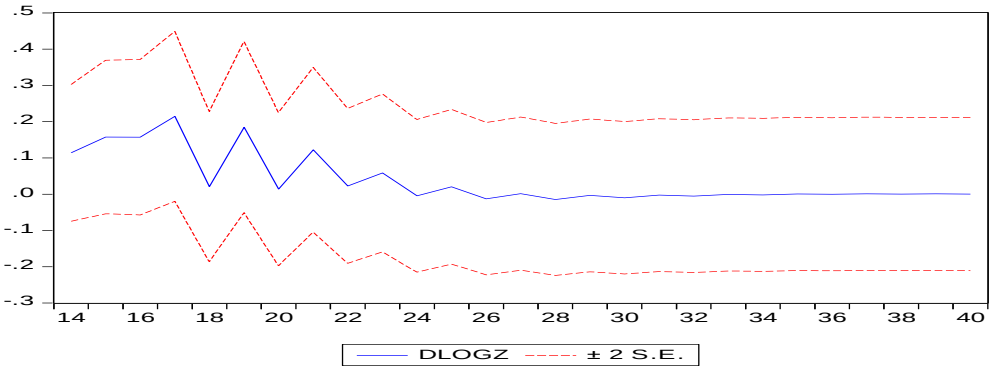
The ECM term is found significant at 5 percent level but the speed of adjustment is low (0.34). As expected the output elasticity is close to unity. The model has passed all the diagnostic tests reported in Table 3.11. The CUSUM and CUSUMSQ tests also suggest that the coefficients are stable.

As shown in Figure 3.12, the impulse response for a shock in real GDP produces quite a strong unsettled pattern for about 10 years until 2025, and throughout this period, the variable reverberates in the positive territory, outside its steady state value.

Table 3-11: Diagnostic Test Results

Tests	Jarque-Bera	ARCH	RESET	LM
Statistic	0.652	1.356	0.504	0.304
p-values	(0.722)	(0.244)	(0.478)	(0.201)

Figure 3-12: Impulse response function for a 10 percent increase in real GDP in 2015



3.7.7 The Demand for Money

Equation (56) reports the estimation result of the demand for money function specified in equation (25) – in short-run dynamic error correction form. The ECM term is significant at

one percent level confirming that the demand for money function in Ethiopia is cointegrated. As theoretically motivated, the long-run elasticity coefficient of real GDP is close to one but a Wald test rejects the null hypothesis that the income elasticity of the demand for money is one.

$$\Delta LOG(M2D\_PD\_A) = -0.147*\Delta LOG(M2D\_PD\_A(-2)) - 0.326*\Delta LOG(M2D\_PD\_A(-3))$$
$$(-1.557) \qquad (-2.07)$$

$$- 0.507*\Delta LOG(Q(-1)) - 0.241*\Delta LOG(Q(-2)) - 0.340*\Delta LOG(Q(-3))$$
$$(-1.718) \qquad (-1.293) \qquad (-1.671)$$

$$- 0.368*\Delta LOG(PC\_ROUT) + 0.400*\Delta LOG(PC\_ROUT(-1)) - 0.538*\Delta LOG(REER)$$
$$(-2.688) \qquad (2.037) \qquad (-7.869)$$

$$- 0.058*\Delta LOG(REER(-1)) - 0.449*\Delta LOG(REER(-3)) - 2.207*\Delta INTRATE -$$
$$(-0.819) \qquad (-4.219) \qquad (-2.601)$$

$$2.930*\Delta INTRATE(-3) \mathbf{- 0.663*[LOG(M2D\_PD\_A(-1)) - 1.091*LOG(Q(-1))}$$
$$(-3.385) \qquad \mathbf{(-4.531)} \qquad \mathbf{(-3.984)}$$

$$\mathbf{+ 1.028*LOG(PC\_ROUT(-1)) - 0.297*DSB2006*LOG(PC\_ROUT(-1))}$$
$$\mathbf{(4.501) \qquad (-2.360)}$$

$$\mathbf{+ 0.451*LOG(REER(-1)) + 2.859*INTRATE(-1) -1.044]} \quad (56)$$
$$\mathbf{(3.721) \qquad (3.189) \qquad (-0.671)}$$

Adjusted $R^2 = 0.814$ $s = 0.041$

Per-capita rural output exercises a negative effect on the demand for money, given real GDP; that is, for a given GDP the larger the amount in the monetized urban and semi-urban areas, the larger is the demand for money. Structural break tests confirm a break in the rural output relationship in 2006. This was the period when the historical link between a good agricultural harvest season and a drop in food inflation began break down. Prior to 2006, food prices used to decline during agricultural harvest season (November to January) and start to rise in the slack season particular during sowing season (June to September).

There were at least two major reasons for the strong seasonal link between harvest and food price cycle. First, there was no organized credit market such as microfinance institutions to smooth out liquidity strains during harvest season; this matters because this is the season that many traditional social activities take place in rural areas, including weddings. A number of religious festivities would also take place during this period.

Second, the rural sellers come from far away with their produce, usually on foot and on horseback. In the absence of telecommunication facilities, they would have no prior information about prices. Hence, during harvest season they all tend to converge on the food market and have to take whatever the market offers because most of them are desperate to get liquid and cover expenses related to non-farm activities. The implication is that, although the rural demand for money increases during harvest season, their income from each unit of their produce declines because of lower prices. The latter is what is reflected as a negative long-run elasticity coefficient of PC_RUROUT prior to 2006. A structural break happens around 2007 because improved access to telecoms, transport facilities and, most importantly, to rural financing schemes that revolutionize rural life and help to break a strong seasonality link between harvests and food prices (Birru, 2007).

Figure 3.13 shows that, before 2007, food inflation was generally low and follows cyclical patterns, swinging between negative and positive territories, which repeat every year, except the drought years of 1985, 1995 and 2003. However, this has changed since 2007. Figure 3.14 illustrates that, despite bumper harvests, food prices did not drop between October and January as it used to do in the previous years. So, rural incomes increase from both a high volume of production and a continuous rise food prices. The delayed delivery of food aid by the World Food Program amounting about USD 140 million that coincided with the 2000/01 bumper harvest led food prices to drop by 60 percent drop in the same year. The food aid had been expected to come in 1999/2000 when the country experienced a moderate drought.

Figure 3-13: Quarterly Trend of Food Inflation in Ethiopia during 1981(QI) - 2006(QIV)

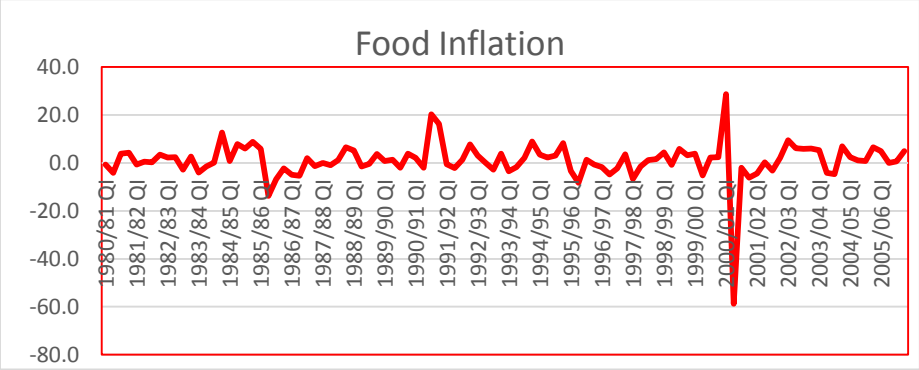
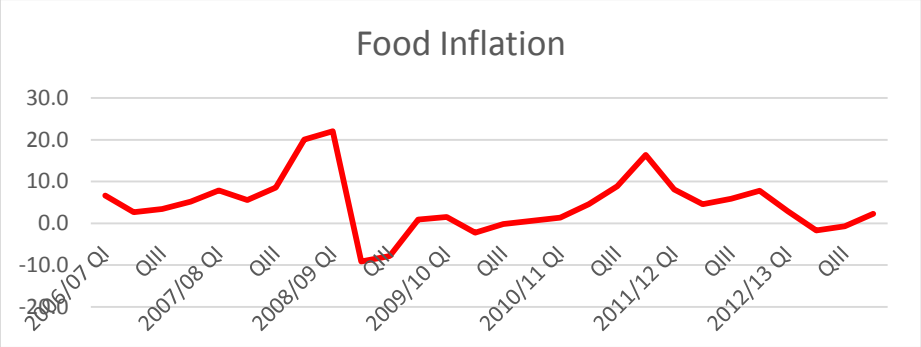


Figure 3-14: Quarterly Trend of Food Inflation in Ethiopia during 2007(QI)-2013(QIV)



The demand for money increases when the domestic currency depreciates. The past relative stability of the Birr and the public confidence that this earned means that expectations tend not to extrapolate from one depreciation to another future one. Thus, as the birr depreciates people tend to hold additional domestic currency per unit of imported goods that reflects the dominance of transactions effect in their decision. Bahmani-Oskooee and Rehman (2005) also documented similar findings for India and Indonesia. On the other hand, exactly as expected, the partial elasticity of money demand with respect to the interest rate is negative, i.e., -2.1, implying that a one percentage point increase the nominal interest rate leads to a 2.1 percent decline in the demand for money. This indicates that the public see interest as an opportunity cost of holding money in Ethiopia.

Money demand shows complex short-term dynamics in Ethiopia – witness the large number of lagged changes in the error correction equation. Figures 3.17-3.19 below show the impulse response functions for GDP, per-capita rural income and the real exchange rate respectively. The figures indicate that adjustments to both income, per-capita rural income and exchange rate shocks appear to reverberating around their respective steady states for quite long periods before settling down.

A. Impulse Response Functions

Figure 3-15 Impulse response function for a 10 percent increase in real GDP in 2014

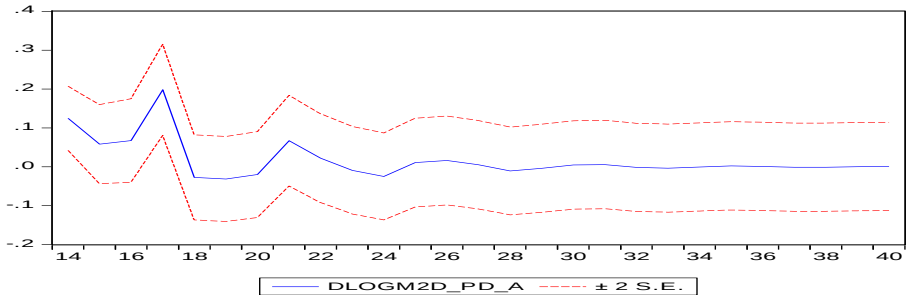


Figure 3-16: Impulse response function for a 40 percent increase in rural per-capita income in 2015

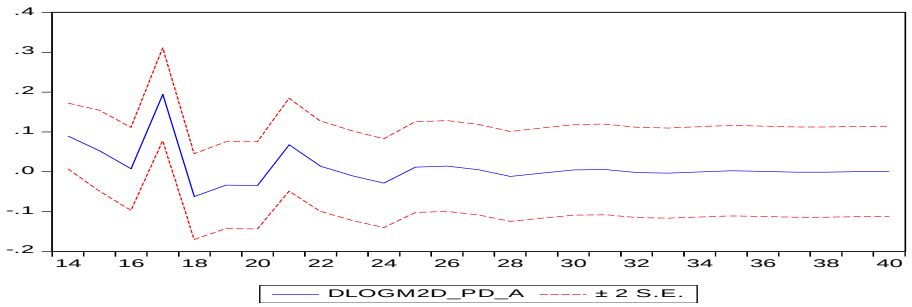
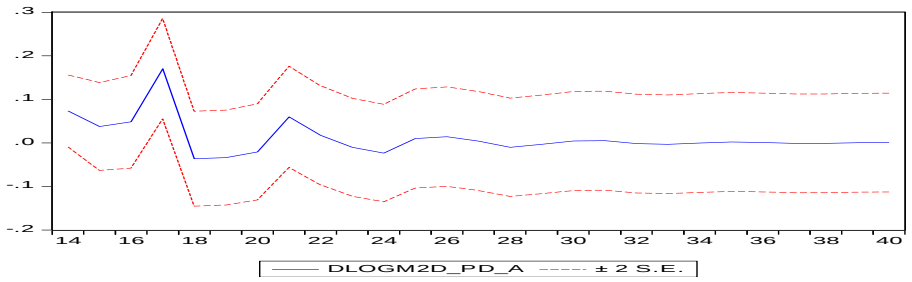


Figure3-17: Impulse response function for a 10 percent appreciation REER in 2014



The demand for money function passes the normality, hetreosckedasticity, and the correct functional form tests. However, it fails to pass the autocorrelation LM tests. As explained in section 3.6.2.2, the presence of autocorrelation in ARDL model is an indication of serial correlation in omitted variables. If the latter case, Green (2000) suggests, trying to relax the non-linear restrictions on the ARDL model as next step and

refitting the model by Feasible Generalized Least Squares (FGLS). However, he also argues, "the asymptotic efficiency of FGLS estimators may not carry over to small samples because of the variability introduced in the estimated Ω". Therefore, Greene (2000, p. 470) continues to argue, "If the departure from the classical assumptions is not too severe, least squares may be more efficient than FGLS in a small samples". The fact that the model passes the RESET test, which is also one of the omitted variable tests, could suggest that the problem is not big enough to be considered as a severe departure from the classical assumptions. So, as suggested by Greene (2000), limited by the small sample problem, we proceed with the estimated equation.

Table 3-12: Diagnostic Test Results

Tests	Jarque-Bera	ARCH	RESET	LM
Statistic	0.954	0.693	0.197	12.302
p-values	(0.621)	(0.683)	(0.657)	(0.001)

B. Stability tests

Figure 3-18: CUSUM

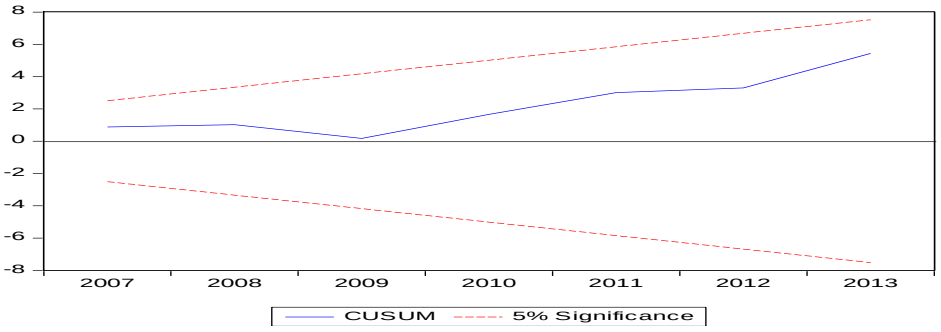
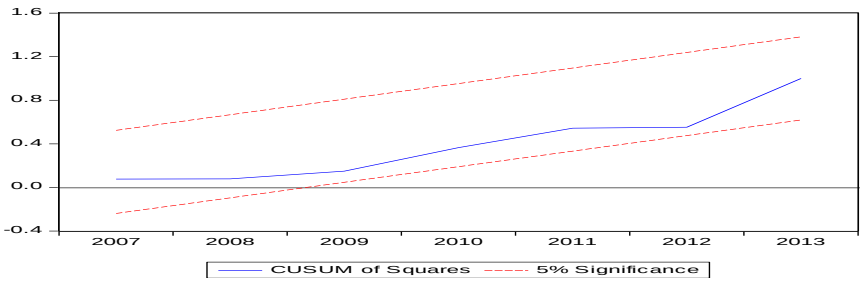


Figure 3-19: CUSUMSQ



3.8 Model Simulation Results

This section presents simulation results of the model. Section 3.8.1 presents within-sample dynamic simulations for the period 2006 - 2013, while section 3.8.2 presents the out of sample forecasts for the period 2014 – 2025. In the latter, I will try to evaluate the feasibility of the policy objectives that are laid out in the vision 2025 statement, and the implications that these targets have for economic policies, assuming that there will be no change in the main targets and policies. The twelve year horizon is based on the remaining two years of GTP I, i.e., 2014 and 2015, followed by two successive GTPs, i.e., GTP II and GTP III, each with five-year duration that leads up to vision 2025. The within-sample simulations use actual values for the exogenous variables during the period between 2006 and 2013. For the forecasts, except in a few cases which demand special judgments, all exogenous variables that are expressed in ratios, are kept constant at their 2013 values while exogenous variables that are not ratios are assumed to grow at their respective growth rates observed during 2011 – 2013. There are also few cases where actual data for 2014 and 2015 is used. The economic targets, such as potential GDP growth, long-term inflation target and international reserve targets are kept unchanged at GTP I levels and I assume, initially, at least, no change in policies exercised during the first three years of the plan period (2011-2013).

Regarding the simulation procedure, as discussed in section 3.6.3, the model is solved simultaneously through an iterative procedure using E-views solver. For presentation purposes, the simulation results are presented visually, with the figures organized into four groups based on market categories, i.e., the real sector, the external sector, the fiscal sector and the saving-investment equilibrium. The monetary sector is combined with the real sector because the two are interwoven in the determination of inflation. In addition, certain results are also tabulated for selected variables.

One modification of the model is important to note, however: the import equation (equation 55) is not used in the empirical simulation model as it made the model unstable. The impulse response function clearly shows that after a shock the variable reverberates outside the steady state value until 2025, which is the entire length of the simulation

exercise (see figure 3.12 on page 93). This affects the stability of the whole model. Hence, in the in-sample simulation, the import model is replaced by an identity using the imports (Z) to GDP (Q) ratio, Φ, as a coefficient to compute the value of imports in a given year, i.e., $Z_t = \Phi_t * Q_t$. Moreover, in the forecast exercise, the import coefficient (Φ_t) is modified exogenously to reflect the expected impact of the process of economic transformation from the agriculture base to a manufacturing base[92]. As a result, the ratio is projected to rise at a rate similar to that observed over the first three years of GTP I (please see Table 3-16, on page 175-132).

3.8.1 Within Sample Simulation: 2006 - 2013

3.8.1.1 Actual vs. Baseline

This section asks how well the simulation model tracks the actual data. The baseline simulation is a simple run of the model without assuming any policy and making the exogenous variable take actual values during the solution period. The model is solved recursively year by year for all endogenous variables for the period 2006-2013 using a dynamic solution.

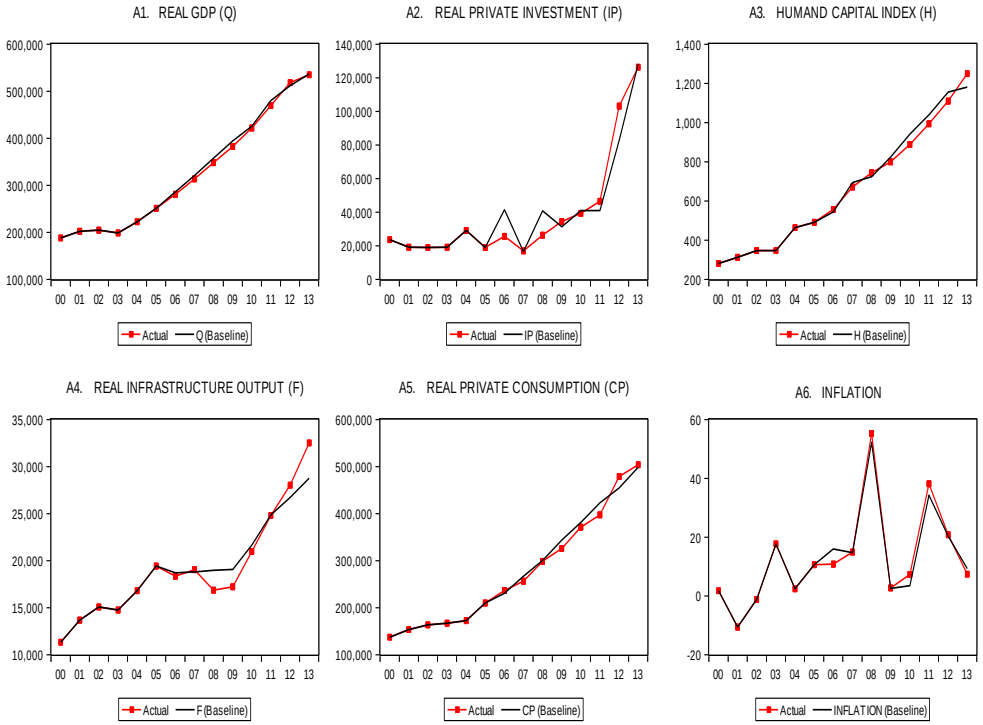
As illustrated in Figures 3-20, the baseline solutions track the actual values well for almost all variables in the real section, with the exception of moderate deviations in private sector investment, inflation and infrastructure services during 2006 and 2007, and an error of trend over the rest of the period in the last five years, i.e., 2008-2013. 2006 and 2007 are the years in which structural breaks are found in the real output growth and money demand models as explained in sections 3.7.1 and 3.7.7, and it is time when the country experienced exogenous shocks associated with the rise in international prices of food.

In the external sector, the baseline simulation of exports and imports of goods and services tracks the actual values reasonably well although there is a persistent small under-prediction of exports. This may be associated to the exogenous shocks in

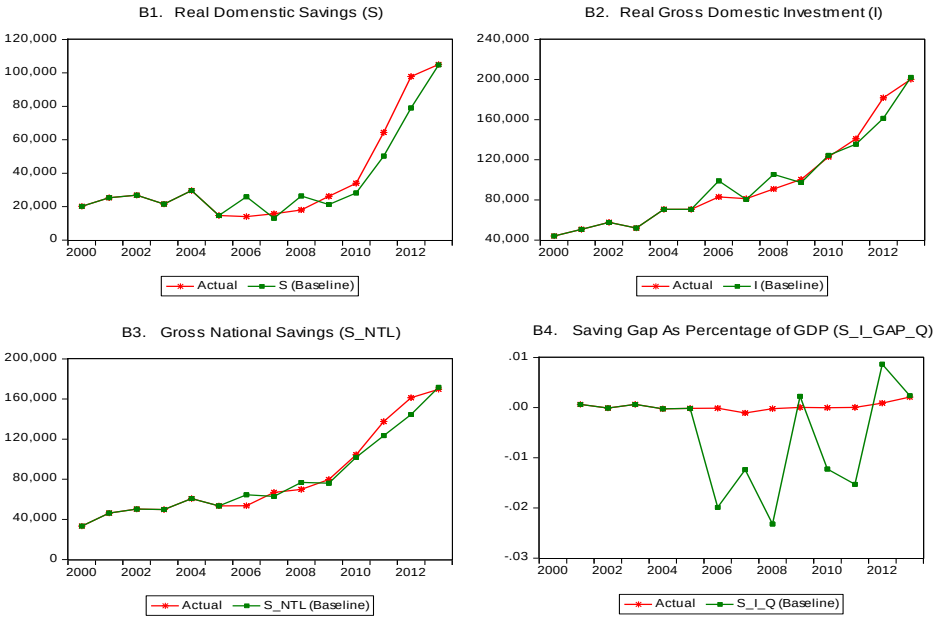
[92] In the entire projection period (2014-2025), imports, particularly imports of capital goods and intermediaries, percentage of GDP are projected to rise steadily.

Figures 3-20: Within-Sample (2006 -2013) Simulation Results: Baseline vs. Actual

A. Real GDP, Investment and Inflation

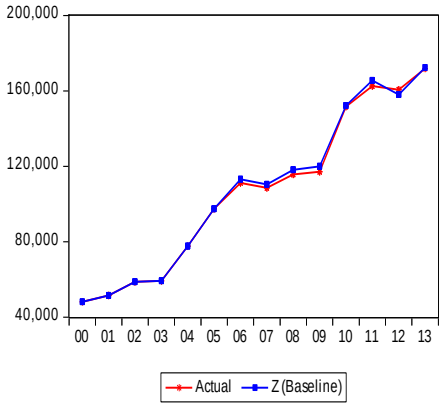


B. Saving and Investment

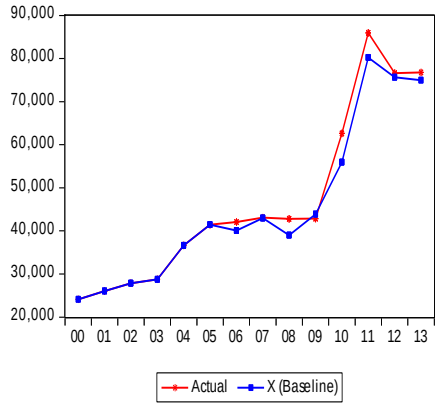


C. External sector variables

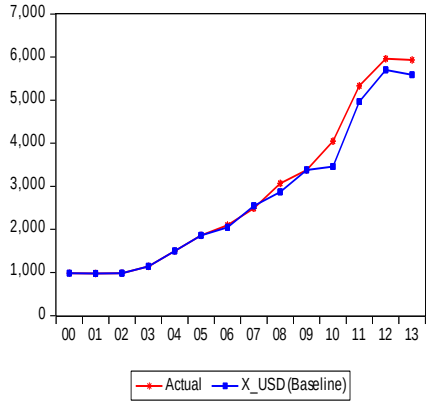
C1. Real Imports of Goods and Services (Z)



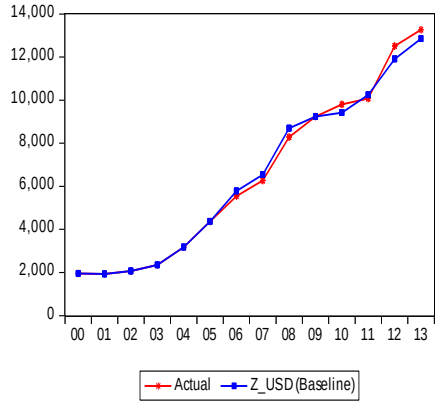
C2. Real Exports of Goods and Srvices (X)



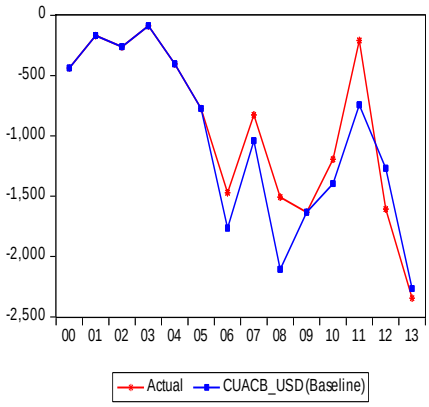
C3. Real Exports of Goods and Services in USD (X_USD)



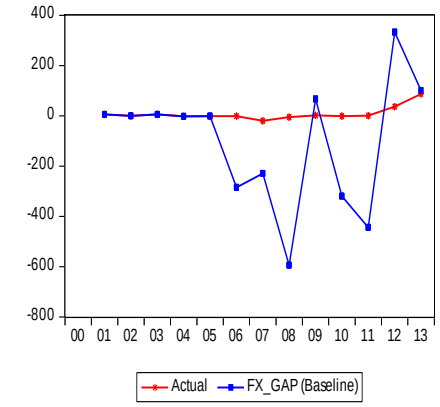
C4. Real Imports of Goods and Services in USD (Z_USD)



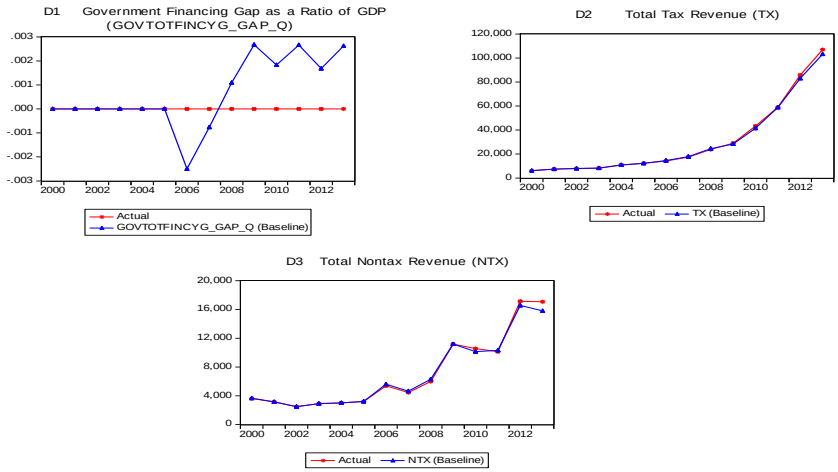
C5. Current Account Balance in USD (CUACB_USD)



C6. Foreign Exchange Gap in USD (FX_GAP)



D. Government Financing Gap



international food prices that happened repeatedly since 2006. Particularly, the export sector benefitted from the rise in prices as more than 70 percent of Ethiopia's exports come from the agriculture sector. Following from the trade results, the baseline simulation of the current account balance is also relatively accurate but with a tendency to slightly exaggerate the deficit. The baseline foreign exchange gap looks extremely bad in figure but that is an artifact of the scale; in fact, the deviations are proportionately very small (the maximum error is 3.8 percent of total imports of goods and services). The deviations in the external sector and savings could be explained by exogenous shock described above which are not well captured by the model.

In the government sector, the figure also looks alarming, but the deviation between the actual and baseline government financing gaps is less than 0.3 percent of GDP, which seems acceptable. The baseline scenarios of domestic savings, national savings and gross fixed investment also track their actual counterparts fairly well. Savings and investment show deviations in 2006 and 2007 related to those observed in the real and external sectors, and there is a tendency for the saving and investment gap to be under-predicted.

Overall, the predictive performance of the model is less than perfect, but not by so much that it is invalidated as a tool for exploring scenarios surrounding the GTP. Before moving on to that, however, I explore some policy experiments for the period 2011-2013, in section 3.8.1.2, below.

3.8.1.2 Simulation Results with Alternative Policy Scenarios

In this section, the model is used to explore two alternative policy scenarios, in order to elucidate its workings more thoroughly. The first assumes a 10-percent one-time nominal devaluation of the Birr against the dollar relative to baseline and the second assumes a 10 percent one-step increase in public investment relative to baseline. The shocks are assumed to happen in 2012. All other policy and exogenous variables are assumed to maintain their baseline values. The results are described in terms of the difference between the scenario and the baseline values of key variables.

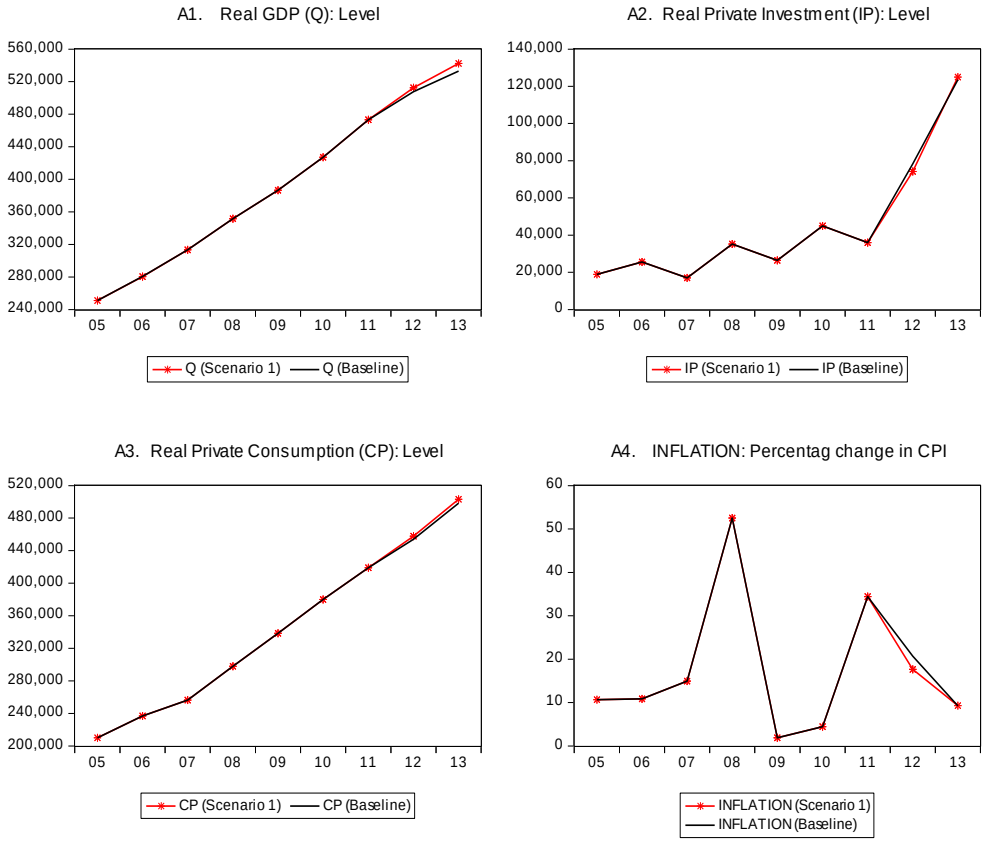
A. A Step Devaluation of the Birr by 10 percent in 2012

This simulation confirms the main hypothesis of a foreign exchange constrained small open economy scenario. A step devaluation of the Birr at the time, when the latter had already had appreciated by more than 15 percent in real terms as domestic inflation surged to close to 39 percent in 2012, results in a significant improvement in the current account of the balance of payment as exports increased moderately while imports increased only slightly. The increase in imports is a scale effect. Consequently, the foreign exchange gap turns more positive. In the money market, the demand for money increases as the Birr depreciates resulting in excess demand for money, pushing down the rate of inflation down. Similar to a typical foreign exchange constrained economies, in Ethiopia, domestic prices of tradable goods, particularly prices of imported goods reflect not the official exchange rate used here, but the black market rate [Dercon, 2002 and Ayalew, 1994]. The gap between official and parallel market exchange rate had already reached 7 percent by 2012, so the recorded depreciation had barely any effect on domestic prices but increased the demand for money because exports are monetized and banks were forced to inject additional liquidity. Figure 3.21(D6) shows the government's financing-gap also moving into the positive space. This is because, as shown in Figure 3.21(D5) the non-bank public are willing to hold more government liabilities as part of their wealth portfolio following higher income flows from exports and export related activities. Corresponding to the government and foreign exchange gaps, the results also show an increased surplus saving-investment balance.

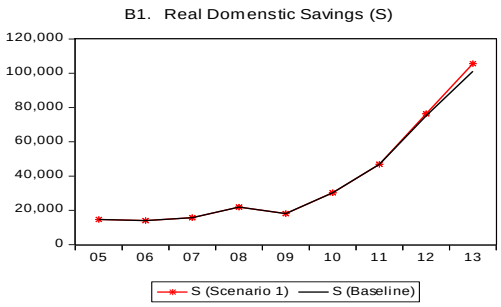
Recall that this model is designed for an exercise in financial programming with endogenous gap variables, i.e., Ωg and Ω, which does not allow for a full set of adjustments that one would find in a forecasting model. Thus, the devaluation has resulted in a series of positive gaps in the foreign, government and savings-investment sectors. In a real economy, these gaps would lead to further adjustments, which would tend to eliminate the excesses according to whatever method was chosen to close the model. The government might adjust its policy stance by, for example, deciding to repay overseas debt and letting the capital account surplus to shrink. However, this would be a controversial policy proposal for a poor country that requires more investment in infrastructure and expanding its productive capacity. Therefore, the other alternative is to let the budget deficit widen by investing on infrastructure and absorb the excesses in the economy.

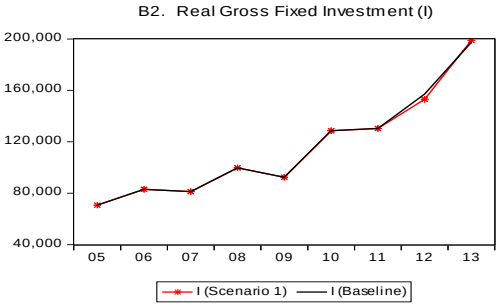
Figures 3-21: Within Sample (2008-2013) Forecasts – The Effects of a 10 Percent Devaluation of the Birr in 2012

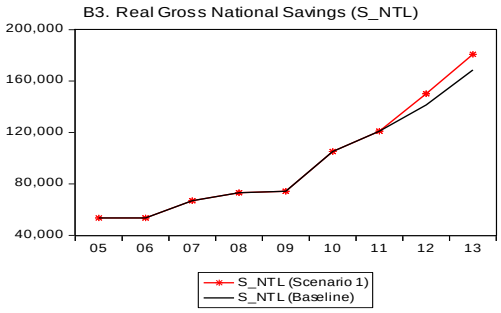
A. Real GDP, Investment and Inflation

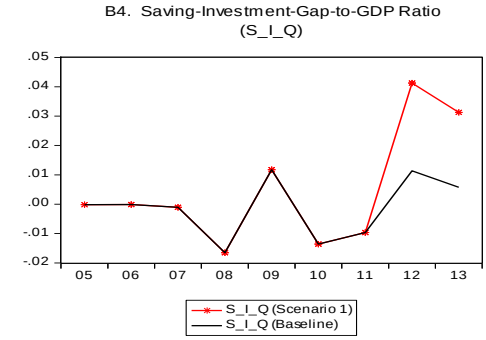


B. Saving and Investment

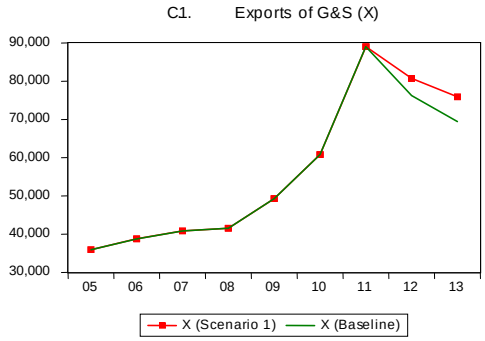


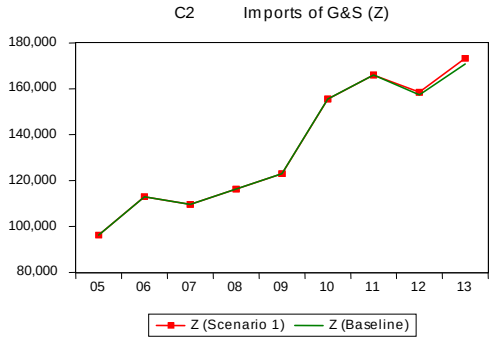


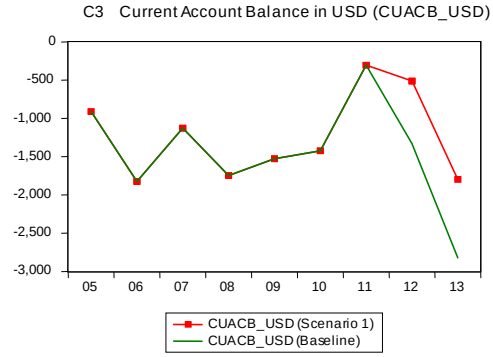


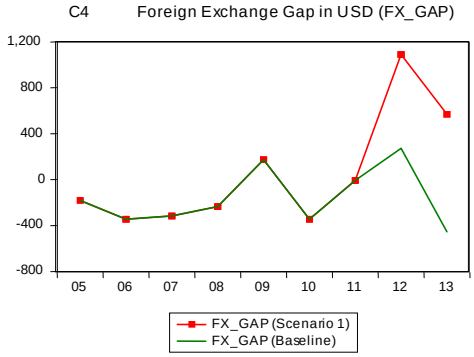


C. External Sector

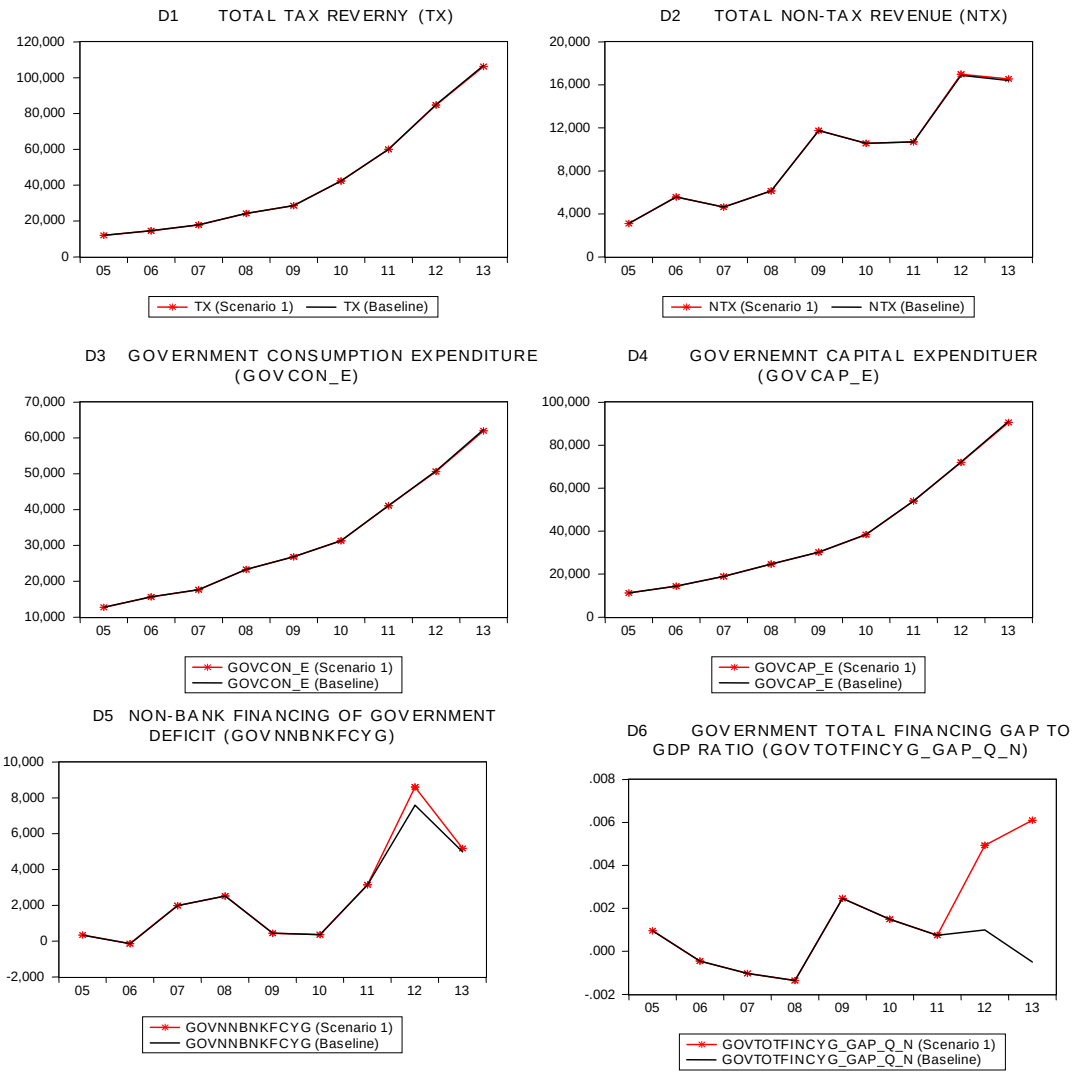








D. Government Financing Gap



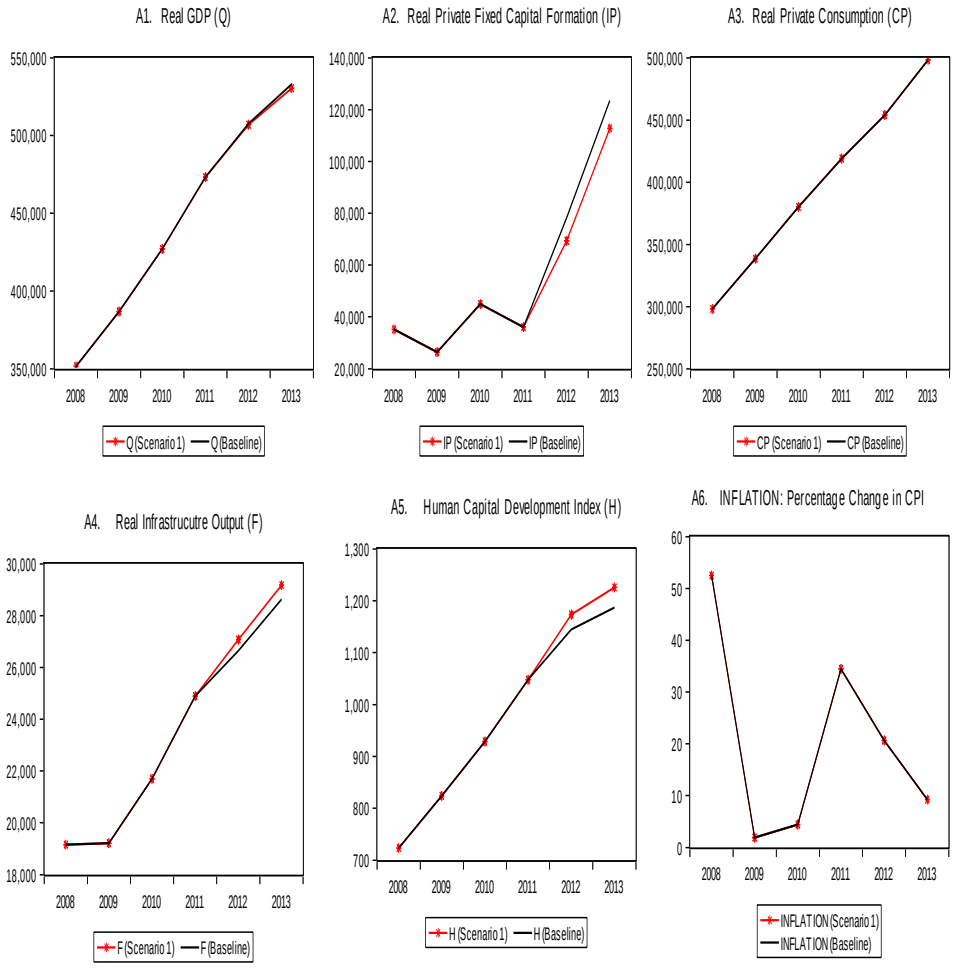
B. A Step Increase in Real Public Fixed Formation by 10 percent in 2012

The second policy scenario is a 10 percent one-step increase in public investment against the baseline in 2012. The results are shown in Figure 3-22 below. In a straight-forward financial programming framework where capacity output is fixed and total investment is calculated using ICOR technique, increasing public sector investment would not increase total investment; instead, it would result in the crowding out of private investment, as

shown in the Real Sector of Figure 3-22(A2). Thus the policy would affect potential output by positively affecting factor productivity through the resulting increase in infrastructure output and human capital stock– see Figures 3-22(A4) and (A5). Short-run aggregate demand, on the other hand, would remain more or less unaffected (Figure 3-22(A1)) despite a conspicuous decline in total gross total fixed investment whose effect seems to be offset by the rise in TFP .

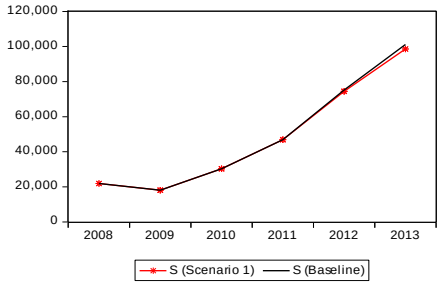
Figures 3-22: Within-Sample (2008-2013) Forecasts – The Effects of a 10 Percent Increase in Public Sector Investment

A. Real GDP, Investment and Inflation

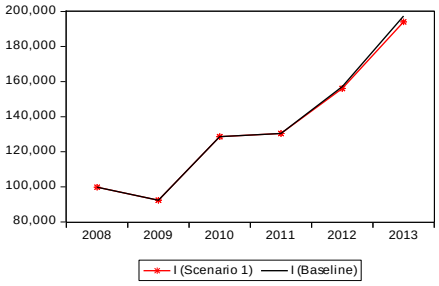


B. Saving and Investment

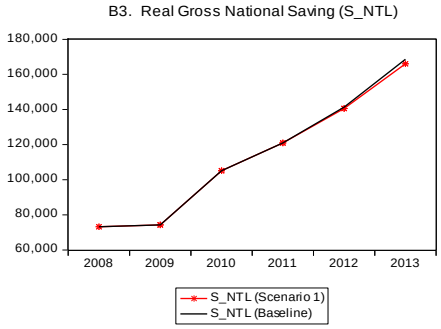
B1. Real Gross Domestic Savings (S)



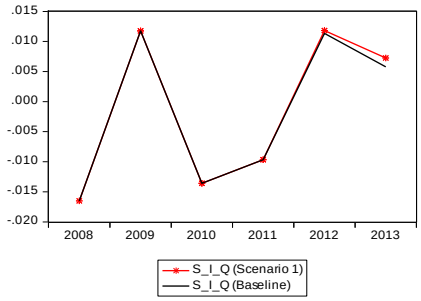
B2. Real Gross Fixed Investment (I)



B3. Real Gross National Saving (S_NTL)

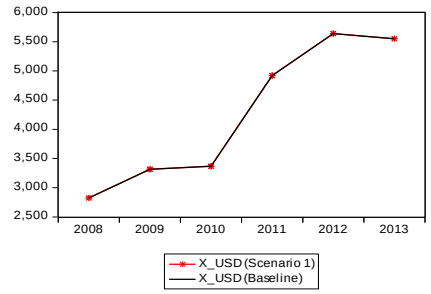


B4. Saving-Investment Gap as a Ratio of GDP (S_I_Q)

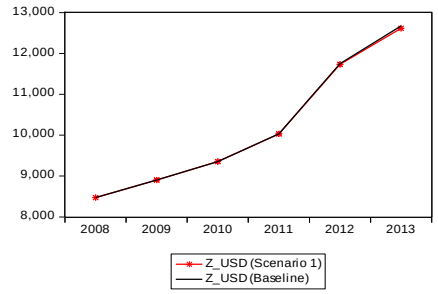


C. External Sector Variables

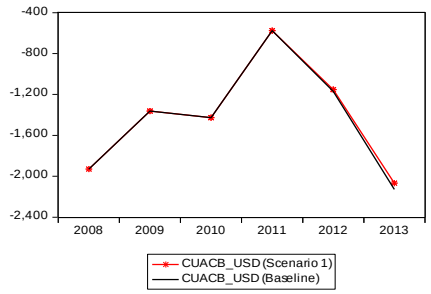
C1. Real Exports of Goods and Services in USD (X_USD)



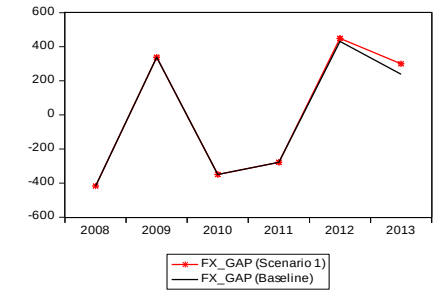
C2. Real Imports of Goods and Services in USD (Z_USD)



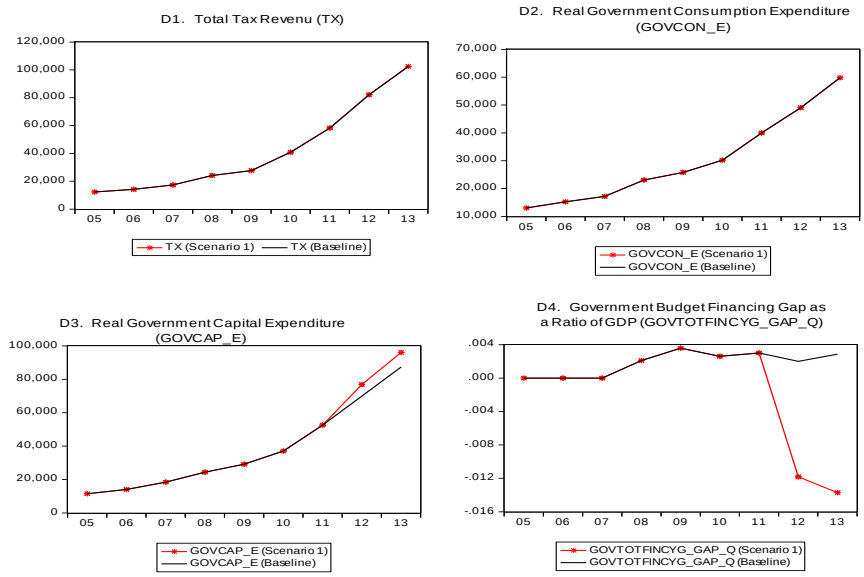
C3. Current Account Balance in USD (CUACB_USD)



C4. Foriegn Exhange Gap in USD (FX_GAP)



D. Government Financing Gap

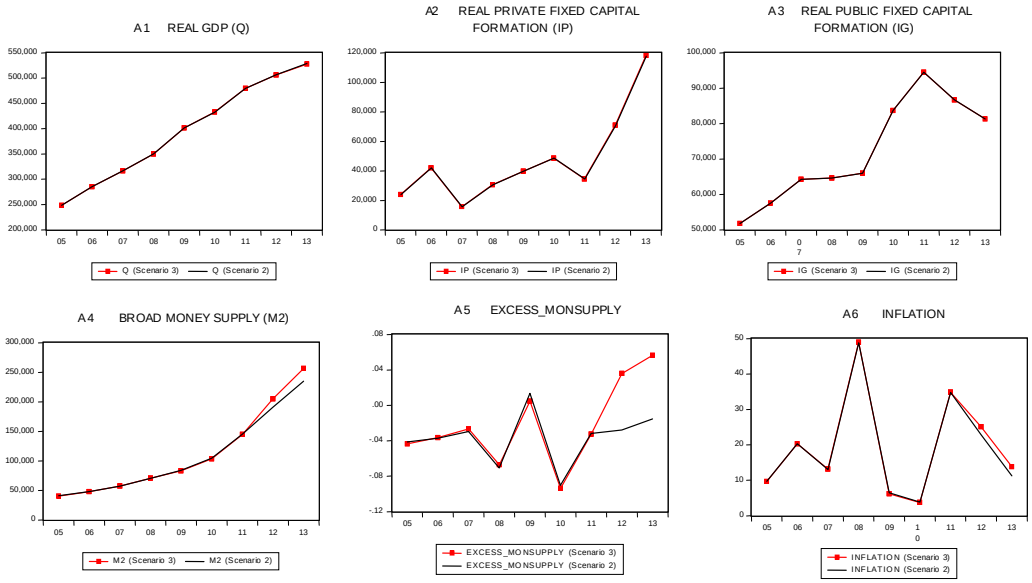


In this scenario, the external current account balance shows some improvement due to slight decline in imports of goods and services following the decline in real GDP. However, the impact is significant in the government sector because the extra public investment drives the government into substantial budget deficit. However, the saving-investment gap has not widened correspondingly because, as Figures 3-22(D3) and (D4) show, the government expenditure is offset by lower private investment demand (Figure 3-22(A2)). The fiscal side could be closed, for example, by letting the yield on government bonds rise and, consequently, attracting the surplus in the private sector.

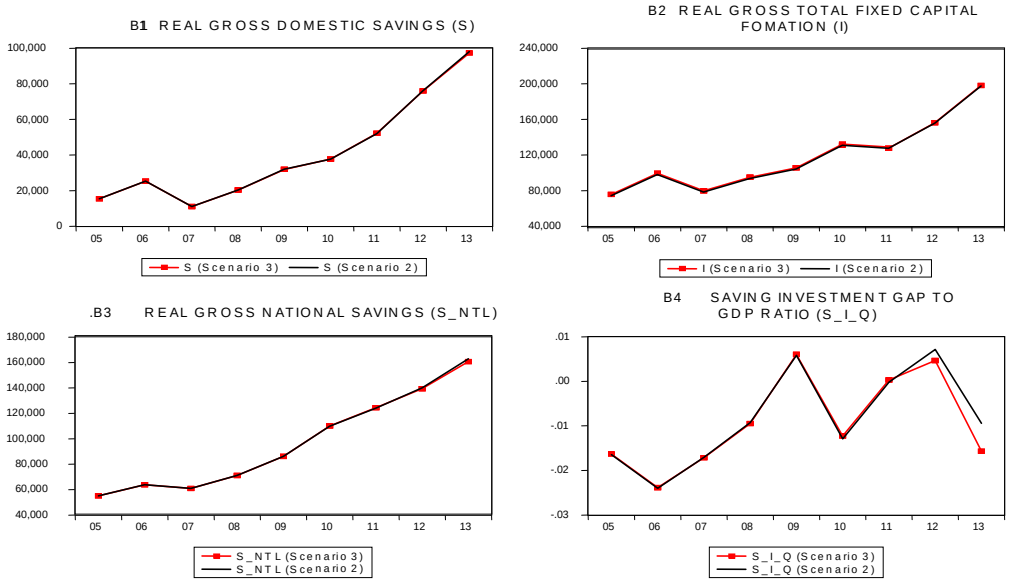
The scenario just described is not very attractive in terms of the needs of a low-income country like Ethiopia. So I now ask the model to explore what would happen if the government wishes to finance the budget deficit resulting from its increased investment on infrastructure by inflationary financing instead of cutting consumption or exploring for additional external financing. If the government decides to finance the resulting deficit through central bank borrowing while letting private investment remain unchanged, it would effectively be raising total investment beyond the level required for the given potential growth rate.

Figures 3-23: Assuming Governemnt Finances the Deficit by Borrowing from the Centeral Bank

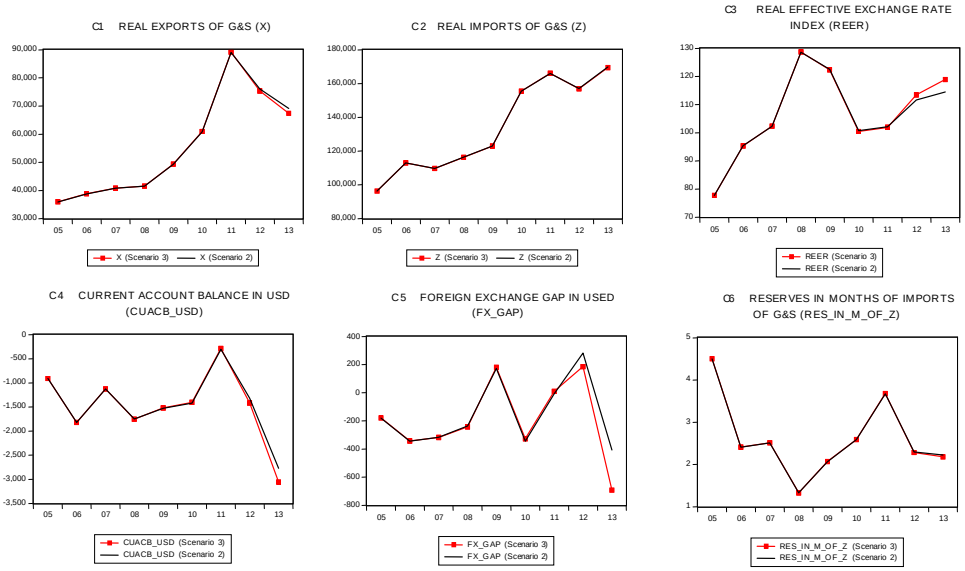
A. Real Sector Block



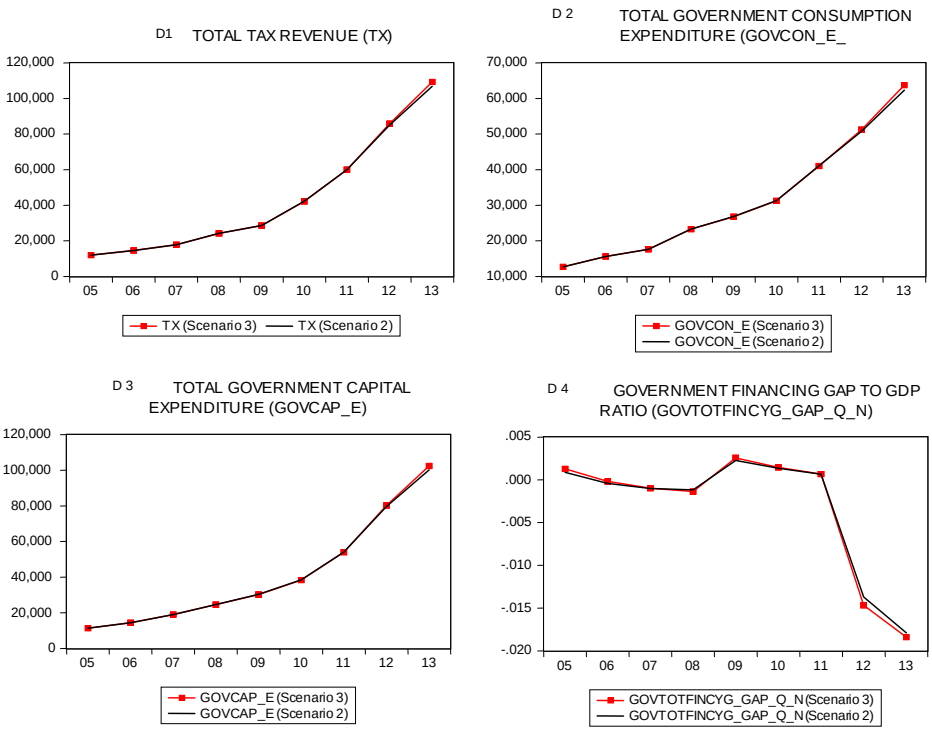
B. Saving and Investment



C. External Sector



D. Government Financing Gap



In the money market, the resulting excess money supply leads to an increase in inflation and this in turn results in a real exchange rate appreciation. Consequently, in the foreign exchange market, exports decline while imports remain unaffected, turning the current account balance and foreign exchange gap to more negative. This increases the saving-investment gap as shown in Figure 3-23(B4). In the immediate future, the solution to close the model is quantitatively by either borrowing from abroad or crowding out more private investment and aggregate consumption. The latter helps to offset the excess investment demand created resulting from the policy scenario.

3.8.1.3 Evaluation of GTP I Target vs. Actual Performance during the First Three years of the Plan Period: 2011-2013

In this section, I try to evaluate the consistency of targets and policy insturments of GTP I using the simulation model. The model is used to reproduce projections of the main macro variables using policy targets and assumptions about policy instruments as laid out in the plan. The plan targets and simulation results of the model will also be compared with actual performaces in the first three years of the plan (2011-2013). While Table 3.13 below provides the main macroeconomic targets and demand side projections of the economy, Table 3.14 presents the assumptions for the main macroeconoimc policy instruments [Federal Democratic Republic of Ethiopia, 2010]. Other macro projections of the plan are provided in Table 3.15 along with simulation results and actual performance. Because of the lack of information on the assumptions in the plan about some exogenous variables, particularly official external borrowing and other public sector net borrowing in the capital account of the balance of payments, actual data is used in the simulation model.

Table 3.15 indicates that in the real sector block, the simulation model is relatively less optimistic about real GDP projections than the plan except in 2013. The difference lies basically on the projections of real aggregate consumption demand. For instance, despite aggressive policies in the real, monetary and external sectors that would shift relative prices in favour of domestic savings, the plan appeared to consistently over-project aggregate

Table 3-13: Main Macroeconomic Policy Targets of GTP I: 2011-2015
(Baseline Case Scenario)

	2010 Base-Year	2011	2012	2013	2014	2015
		Targets				
Real GDP (Q) (% Change)	10.4	11	11.1	11.3	11.2	11.4
Inflation (% Change)1/	7.5	9	9	9	9	9
Domestic Savings (% GDP)	5.5	7.4	10.4	12.4	14.4	15
Tax Income (% GDP)	11.3	11.7	12.1	13.2	14.7	15
Non-tax Income (% GDP)	2.8	2.4	2.1	2.1	2.1	2.1
	Projections (as percent of GDP)					
Aggregate Consumption Demand (C)	94.5	92.6	89.6	87.6	85.6	85
Gross Fixed Capital Formation (I)	22.3	25.3	27.2	28.1	28.9	28.2
Exports of Goods and Services (X)	13.6	16.6	17.7	19.2	20.8	22.5
Imports of Goods and Services (Z)	33.0	34.0	34.5	35.0	35.3	35.7

Source: Federal Democratic Republic of Ethiopia, Growth and Transformation Plan (2010/11 – 2014/15), Ministry of Finance and Economic Development, November 2010, Addis Ababa.

1/ The target is single-digit inflation. But, for operational purpose the NBE uses 9 percent target.

Table 3-14: Main Macroeconomic Policy Instruments in GTP I: 2011-2015

	2010 Base Year	2011	2012	2013	2014	2015
		Targets				
Nominal Exchange Rate (% depreciation)	23.7	25.0	5.0	5.0	5.0	5.0
Gov't Consumption Expenditure (% GDP)	8.4	8.9	8.6	8.8	9.1	9.3
Gov't Capital Expenditure (% GDP)	10.3	11.6	11.6	12.3	13.3	14.4
Nominal interest rate (% Change)	4.0	5.0	5.0	5.0	5.0	5.0
Gov't Borrowing from NBE (in Millions of Birr)	822.0	1000.0	0.0	0.0	0.0	0.0
Statutory Reserves of Banks (% of Net Deposits of the Banking System)	15.0	15.0	15.0	15.0	15.0	15.0

Table 3-15: Comparison of the Plan against Model Simulation Results and Actuals

	2011			2012			2013		
	Plan (GTP-I)	Simulation Result	Actual	Plan (GTP-I)	Simulation Result	Actual	Plan (GTP-I)	Simulation Result	Actual
I. The Real Sector (Demand Side), Money Market and Prices	% Change								
Real GDP (Q)	11.0	10.4	11.3	11.1	7.2	8.7	11.3	13.0	9.7
Consumer Price Index (PD_A)	9.0	24.4	33.1	9.0	20.4	30.1	9.0	7.2	12.3
	As Percentage of GDP								
Aggregate Consumption Demand (C)	92.6	90.0	86.3	89.6	79.1	78.2	87.6	81.4	77.6
Gross Fixed Capital Formation (I)	25.3	26.6	28.2	27.2	33.2	36.0	28.1	36.9	38.4
Exports of Goods and Services (X)	16.6	16.9	18.3	17.7	15.9	14.8	19.2	14.6	14.4
Imports of Goods and Services (Z)	34	34.0	34.6	34.5	30.0	31.5	35.0	35.0	30.7
II. Saving-Investment Balances	As Percentage of GDP								
Gross Domestic Savings (S)	7.4	10.0	13.7	10.4	20.9	18.9	12.40	18.6	19.6
Gross National Savings (S_NTL)	-	25.3	29.3	-	33.1	31.1	-	30.1	31.7
Domestic Savings-Investment Gap (S_DOM_I_Gap)	-17.9	-16.6	-14.5	-16.8	-12.3	-17.1	-15.7	-18.3	-18.8
National Savings -Investment Gap (S_I_Gap)	-	-1.9	-0.7	-	-2.5	-4.0	-	-9.4	-5.4
Savings-Investment Gap after Financing from foreign Savings (S_I)	-	1.91	0.30	-	-0.93	-0.01	-	-3.3	0.05

Note: The dash sign '-' indicates data is not available

Table 3.15 (Cont'd): Comparison of Plan Projections against Model Simulation Results and Actuals: (2011 -2-12)1/

	2011			2012			2013		
	Plan GTP-I	Simulation Result	Actual	Plan GTP-I	Simulation Result	Actual	Plan GTP-I	Simulation Result	Actual
III. External Sector	As Percentage of GDP (Unless and Otherwise Stated)								
Resource Balance (X-Z)	-17.4	-17.1	-16.3	-16.8	-14.1	-16.7	-15.8	-20.4	-16.3
Current Account Balance (CUACB_USD)	-	-1.9	-0.7	-	-3.6	-5.4	-	-13.2	-7.6
Foreign Exchange Gap (FX_GAP_Q)	-	2.0	0.0	-	-1.3	0.12	-	-4.7	0.3
Change in Gross Int'l Reserves Target (in Mill. Of USD) (BBGROSR_USD)2/	$200.0	$200.0	$1080.9	$200.0	$200.0	-$873.3	$200.0	$200.0	$101.9
REER (% Change)	-19.4	-0.6	3.3	-3.0	7.1	10.50	0.5	-1.2	2.8
IV. Fiscal Sector	As Percentage of GDP								
Total Tax Revenue (TX)	11.3	12.6	11.7	-	12.5	12.1	-	13.6	13.2
Total Non-Tax Revenue (NTX)	2.8	2.2	2.2	-	2.5	2.5	-	2.2	2.2
Government Consumption Expenditure (GOVCON_E)	8.9	8.7	8.6	8.60	7.8	7.5	8.8	8.1	8.0
Government Capital Expenditure (GOVCAP_E)	11.6	10.8	11.4	11.60	13.6	10.6	12.3	17.1	11.6
Government Total Financing Gap (GOVTOTFINCYG_GAP)	0.00	0.00	0.00	0.00	-0.04	0.00	0.00	-0.07	0.00

1/ The dash sign '-'indicates data is not available

2/ BBGROSR_USD is one of exogenously determined policy targets of the plans so that the model uses it directly.

consumption throughout the first three years of the plan (2011-2013). While the plan forecasts aggregate consumption to decline only by 1.9 percentage point of GDP, from 94.5 percent of GDP in 2010 to 92.6 percent in 2011, the model projected consumption to decline to 90 percent of GDP in the same period. This difference appears to be the major explanation for the difference in real GDP growth projections. The model projections are closer to the actual performance than the plan forecasts. On the other hand, although the plan believes that investment would be the main source of growth, generally, it appears to underestimate the amount of investment needed to bring about the targeted 11 percent GDP. For instance, using the ICOR method, the model projected the total investment requirement to achieve the projected 11 percent growth at 33.2 percent and 36.9 percent of GDP for 2012 and 2013 respectively, while the plan projected at 27.2 and 28.1 percent. As is illustrated in Table 3.15, the actual investment demand in 2012 and 2013 stood at 36 percent and 38.4 percent of GDP respectively, which are closer to the simulation results than the plan projections.

On the other hand, the plan projected a higher contribution of exports of goods and services to GDP growth compared with the model despite lack of clear policies to boost export growth over the plan period. The appreciation of the exchange rate by 14% between 2011 and 2013 depressed exports growth and contributed a fair share of the deviation between the actual and projected growth rates in two ways. First, as a component of the demand side of the GDP, lower growth in exports means a lower contribution to growth. Second, the export spillover effect on TFP would also be lower. Had it not been for the growth of investment, GDP growth would have been much lower than the ones that were actually achieved. This is one of the inconsistencies of the plan. The over-performance of investment growth was made possible by the higher than planned growth in domestic savings. The model also projected domestic savings-to-GDP ratio to reach 20.9 percent and 18.9 percent in 2012 and 2013 respectively. The latter are relatively close to the actual outturn than the plan.

In the external sector, the plan is a little more optimistic about the trade balance than the simulation mainly due to its having a higher projection of export growth than the model. Consequently, gross international reserves were projected to see continuous build-ups of

USD 200 million every year throughout the plan which is different from the actual outturn. On the other hand, the model takes gross reserves as a policy target so that its projection is not different from the plan. Not surprisingly, many of the projections of the plan and the model are close to each other, because, first, the fiscal sector is mostly government policy determined, and second, the model uses identities to project most of the variables in this sector, which is similar to the method used by the plan. One exception to this is the case of government capital expenditure in 2013, because the model projects gross fixed capital formation to reach 36.9 percent of GDP (compared with the 28 percent share in the plan) and the simulation projects the lion's share of the increase to come from government capital formation. The model is closer to the actual outturn in terms of the prediction of gross total fixed capital formation. However, the main source of the increase in the latter turned out to be the surge in private capital formation contrary to the model's prediction of government capital formation.

To conclude, the plan appears to project growth and many of the demand side variables such as imports and government expenditures relatively well. However, it underestimates investment and domestic savings which are the key determinants of growth and the resource gaps. On the other hand, despite the lack of clear policies in the external sector, the plan seems to overestimate export growth. Applying the same set of policies that are laid out in the plan, the model's projections of exports are much lower than the plan's.

3.8.2 Out-of-Sample Simulation Exercises: 2014-2025

The following two sections present baseline out-of-sample forecasts, simulation results, and the policy implications under different scenarios. While the simulations for the baseline are run from 2009 to 2025, the simulations for the policy scenarios run from 2014 to 2025. Fiscal year 2025 is the expected year of the completion of the Third Five-Year Growth and Transformation Plan (GTP-III) when Ethiopia hopes to realize its vision of becoming a middle-income country. The period 2009-2013 is included in baseline simulation to demonstrate how the simulation tracks the actual before it projects 12 years into the future.

3.8.2.1 Simulation Scenarios

Developments over the first three year of the plan were mixed. The economy grew at an average rate of 9.9 percent, but average annual inflation was 24.9 percent and foreign exchange constraints started to suppress investment demand. Contrary to a significant reduction in the current account deficit in the first year of the plan (from USD 1.2 billion in 2010 to USD 0.2 billion in 2011), which reflected a 32 percent increase in exports of goods and services following the major devaluation of the Birr, the foreign exchange gap continued to widen in the following two years. In 2012 and 2013, exports of goods and services growth decelerated to 11 percent and -0.5 percent respectively. On the other hand, the investment-to-GDP ratio grew steadily, reaching 35.7 percent in 2013 from 29.1 in 2010, one year before the plan. The investment boom was largely financed by surging domestic savings, which overshot the five-year target of raising the domestic-saving-to-GDP ratio to 15 percent within the first three years. By 2013, the domestic-saving-to-GDP ratio had already reached 19.6 percent.

In the baseline forecast scenario, this section examines two questions. First, 'is the double digit average growth target attainable given current policy environment?' Second, 'what could be the major growth constraints in the coming 12 years, including the next two Growth and Transformation Plans that are expected to take the country into vision 2025?' This represents a classic use of a financial programming model – it takes some targets and some policy positions and asks whether, given the underlying behavior of the economy, they are mutually consistent. As noted above, inconsistencies show up either as non-zero financing gaps in the government, foreign exchange and savings-investment budgets or missing the targets despite available resources. The latter may arise when the policy mixes are not well aligned with the stated objectives.

Given the information from the baseline simulation, the section then introduces some policy changes by shocking selected policy instruments, to assess the response in growth and inflation targets, and examine reactions in the goods and money markets, saving-investment equilibrium, external sector and fiscal sector. Finally, I take the GTP's targets

and use an E-Views solver to derive the equilibrium policy path, for a selected policy instrument, by forcing the model to solve for a zero foreign exchange gap.

In this model, international gross reserve target is given. It is exogenously determined by policy, and the National Bank of Ethiopia's intervention in the foreign exchange market is always based on this target so that the short-term and long-term targets for gross international reserves are similar. On the other hand, short-run aggregate supply and the short-run inflation rate are determined in the market. Hence, as noted in section, 3.5, in the short-run, output and inflation can temporarily deviate from their respective long-term trends.

3.8.2.2 Baseline Forecast

A. Major Assumptions

The baseline scenario aims to achieve three policy targets from the GTP: the potential growth rate target, the inflation target and the gross international reserves target are all assumed to remain unchanged from the previous three year of GTP I. Table 3.16 summarizes the assumptions about the main exogenous variables. On average, real GDP is targeted to grow at an annual average rate of 11 percent; long-term inflation is targeted to remain in single digits; and gross international reserves in months of next year's import of goods and services not to go below two months. No change in policies is assumed and no new policy instruments are introduced. Exogenous variables - population (urban, rural and total), private transfers, workers' remittances, commercial banks' NFAs, other items nets (central bank and banking system) and the agricultural output to GDP ratio - are assumed to grow at their respective annual average rates of growth in the previous three year (2011 - 2013). Where policies are expressed in terms of proportions of GDP, such as the government investment to GDP ratio, the

Table 3-16: Projections of Main Exogenous Variables and Policy Targets

YEAR	BB GROSR _USD	BB NPVT	CB NFA _USD	CG _Q	DBB NGOV	E	F_BOR_ NET _USD	F_BOR _OTH _NET _USD	FDI _USD	g^T	GOV CAP _E_R	GOV CON _E_R	GOV EXT FCY G_R
2011	3198.0	6250.0	1406.9	0.09	5976.0	16.1	1019.3	430.3	1242.5	11.0	0.56	0.93	0.48
2012	2324.7	12502.0	1074.4	0.09	4433.9	17.3	937.8	230.8	1072.1	11.0	0.69	0.87	0.40
2013	2426.6	16507.0	1154.6	0.09	7725.1	18.2	1687.5	398.9	1231.6	11.0	0.72	0.91	0.55
2014	2669.3	20257.0	1270.1	0.09	9656.4	19.3	1940.6	608.1	1359.2	11.0	0.72	0.91	0.55
2015	2936.2	29157.0	1397.1	0.09	12070.5	20.4	2231.7	927.0	1500.0	11.0	0.72	0.91	0.55
2016	3229.8	21867.8	1536.8	0.09	15088.1	21.7	2566.5	1413.0	1655.4	11.0	0.72	0.91	0.55
2017	3552.8	14578.5	1690.5	0.09	18860.1	23.0	2951.4	2154.0	1826.8	11.0	0.72	0.91	0.55
2018	3943.6	16036.4	1775.0	0.09	20934.7	24.4	3246.6	2369.4	2016.1	11.0	0.72	0.91	0.55
2019	4416.8	17640.0	1863.8	0.09	23237.5	25.8	3571.3	2606.4	2224.9	11.0	0.72	0.91	0.55
2020	4946.9	19404.0	1957.0	0.09	25793.7	27.4	3928.4	2867.0	2455.4	11.0	0.72	0.91	0.55
2021	5540.5	21344.4	2054.8	0.09	28631.0	29.0	4321.2	3153.7	2709.8	11.0	0.72	0.91	0.55
2022	6205.3	23478.8	2157.6	0.09	31780.4	30.8	4753.3	3469.1	2990.5	11.0	0.72	0.91	0.55
2023	6950.0	25826.7	2265.4	0.09	35276.2	32.6	5228.7	3816.0	3300.3	11.0	0.72	0.91	0.55
2024	7784.0	28409.4	2378.7	0.09	39156.6	34.6	5751.5	4197.6	3642.2	11.0	0.72	0.91	0.55
2025	8718.1	31250.3	2497.7	0.09	43463.8	36.6	6326.7	4617.4	4019.5	11.0	0.72	0.91	0.55

Note: BBGROSR_USD=NBE gross reserve in USD; BBNPVT = NBE claims on private sector; CBNFA_USD = commercial banks' NFA; CG_Q = gov't consumption expenditure to government consumption demand (in the national accounts) ratio; DBBNGOV = change in NBE's net claims on Gov't; E = exchange rate (Birr/USD); F_BOR_NET_USD = net official foreign borrowing in USD; F_BOR_OTH_NET_USD = net foreign borrowing of other public sector in USD; FDI_USD = foreign direct investment in USD; g^T = growth target; GOVCAP_E_R = gov't capital expenditure to public fixed capital formation ratio; GOVCON_E_R = gov't consumption expenditure to total government consumption demand (in the national accounts); and GOVEXTFCYG_R = gov't external financing to official foreign borrowing

Table 3-16 (Con'd): Projections of Main Exogenous Variables and Policy Targets

YEAR	GOVNNBNKFCYG_R	GOVRESFCYG	GRANT_R	IG_Q	INTRATE	N_TOT_P	NTX_R	OFFTRANSW_USD	PD	PVTRANSW_USD	QAG_R	SHT_CAP_USD	TX_R	TX_Y_R	Φ
2011	0.08	311.3	0.55	0.20	0.05	82213.0	0.02	1860.7	100.0	2746.7	0.45	-156.6	0.13	0.04	34.6
2012	0.17	-1564.5	0.42	0.15	0.05	84321.0	0.03	1787.9	120.8	3245.8	0.44	-120.9	0.13	0.04	31.0
2013	0.11	-11946.3	0.47	0.13	0.05	86614.0	0.02	1529.9	129.7	3577.5	0.43	-91.6	0.14	0.05	32.1
2014	0.11	-11946.3	0.47	0.13	0.05	88899.2	0.02	1529.9	140.1	3932.4	0.42	-137.4	0.14	0.05	32.8
2015	0.11	-11946.3	0.47	0.13	0.05	91244.6	0.02	1529.9	151.3	4322.5	0.41	-206.1	0.14	0.05	33.4
2016	0.11	-11946.3	0.47	0.13	0.05	93651.9	0.02	1529.9	163.4	4751.2	0.39	-309.2	0.14	0.05	34.1
2017	0.11	-11946.3	0.47	0.13	0.05	96122.8	0.02	1529.9	176.5	5222.6	0.38	-463.7	0.14	0.05	34.8
2018	0.11	-11946.3	0.47	0.13	0.05	98658.8	0.02	1529.9	190.6	5740.6	0.38	-602.8	0.14	0.05	35.5
2019	0.11	-11946.3	0.47	0.13	0.05	101261.8	0.02	1529.9	205.8	6310.1	0.38	-783.7	0.14	0.05	36.2
2020	0.11	-11946.3	0.47	0.13	0.05	103933.4	0.02	1529.9	222.3	6936.0	0.37	-1018.8	0.14	0.05	36.9
2021	0.11	-11946.3	0.47	0.13	0.05	106675.5	0.02	1529.9	240.1	7624.1	0.37	-1324.4	0.14	0.05	37.6
2022	0.11	-11946.3	0.47	0.13	0.05	109490.0	0.02	1529.9	259.3	8380.4	0.37	-1721.8	0.14	0.05	38.4
2023	0.11	-11946.3	0.47	0.13	0.05	112378.7	0.02	1529.9	280.0	9211.7	0.36	-2238.3	0.14	0.05	39.2
2024	0.11	-11946.3	0.47	0.13	0.05	115343.6	0.02	1529.9	302.4	10125.5	0.36	-2909.8	0.14	0.05	39.9
2025	0.11	-11946.3	0.47	0.13	0.05	118386.7	0.02	1529.9	326.6	11129.9	0.35	-3782.7	0.14	0.05	40.7

Note: GOVNNBNKFCYG_R = gov't non-bank financing to change in broad money ratio; GOVRESFCYG = government residual financing; GRANT_R = budgetary grant to official transfer ratio; IG_Q= pubic fixed capital formation to GDP ratio; INTRATE = nominal interest rate; N_TOT_P = total population; NTX_R = non-tax revenue to GDP ratio; OFFTRANSW_USD = official transfer in USD; PD = consumer price index; PVTRANSW_USD = private transfer in USD; QAG_R = agricultural output to GDP ratio; SHT_CAP_USD = net short-term capital inflow; in USD; TX_R = total tax revenue to GDP ratio; and Φ = imports of goods and services to GDP ratio.

government consumption to GDP ratio, tax revenue to GDP ratio, and various components of monetary liabilities (i.e., currency in circulation, savings deposit, time deposits and excess reserves) to demand deposit ratios, these are assumed to remain constant at their 2013 values.

B. Simulation Results

Table 3.17 and Figures 3.24 present simulation results of the baseline forecast. The forecasts indicate that maintaining the target potential GDP path requires high private and public investment ratios (Table 3.17 and Figures 3-24(A3) and (A4)) supported by growing total factor productivity growth sustained through human capital and infrastructure output growth (Figures 3-24(A5) and (A6)). This indicates that the program growth is attainable if these necessary conditions in other markets can be fulfilled. However, the model shows that achieving this would put great strain on the money market, which shows a growing disequilibrium, especially in the first two years of the forecast period – Figure 3-24(A7). As a consequence of this, inflation is forecast to rise close to 16 percent in 2015 before decelerating and briefly touching the single digit regime in 2018. Over the long-term, inflation hovers around 12.5 percent on average, missing the single digit target of the plan. The forecast hike in inflation aggravates an already bad situation in international competitiveness. Associated with the disequilibrium, actual GDP (Figures 3-24(A1) and (A2)) grows a little above the trend in potential GDP at 12.1 percent (Table 3.17) and, despite the strong growth, ratio of exports of goods and services to GDP averaged over the forecast period is forecast to drop slightly to 13.4 percent from 13.7 percent in 2013 actual (13.7 percent).

The need for strong investment to maintain real growth significantly widens the saving-investment gap over the forecast period. The forecasts in Table 3.17 and Figures B4 and B6 show that saving-investment gap widens continually as a ratio of GDP throughout the forecast period, and reaches 17.5 percent by 2025, even after financing part of the gap from trend-based projected foreign savings, in the capital account of the balance of payments. This implies that the plan is inconsistent as it stands now without revising the targets or reconsidering additional policy measures that could address the

Table 3-17: Simulation Forecast Results for Baseline Scenario: 2014-2015(for Selected Goods, Money and External Markets Variables) [1/]

		Investment Requirement					External Sector				
	Long-term Output Growth Target (gT)	Public Investment Requirement (IG_Q)	Private Sector Investment Requirement (% GDP) (IP_Q)	Total Investment Requirement (% GDP) (I_Q)	Short-Run Aggregate Supply Growth (Q%)	Inflation	Exports of G&S (% GDP) (X_USD_Q)	Resource Gap (% GDP) (X-Z_USD_Q)	Current Account Balance (in Millions of USD) (CUACB_USD)	Foreign Exchange Gap (% GDP) (FX_GAP_Q)	Saving-Investment Gap (S_I_Q)
	Target	Policy	Baseline								
2013[1/]	11.0	13.2	22.6	35.8	9.7	12.3	13.7	-17.0	-$2,346	0.2	0.0
2014	11.0	13.2	24.2	37.4	12.0	13.3	14.8	-17.9	-$3,573	-1.6	-1.6
2015	11.0	13.2	31.1	44.3	14.9	16.8	13.8	-19.6	-$6,294	-4.7	-4.7
2016	11.0	13.2	31.7	44.9	11.2	13.4	12.0	-22.1	-$9,004	-6.9	-6.9
2017	11.0	13.2	26.5	39.7	6.1	9.5	12.4	-22.4	-$9,638	-5.9	-5.9
2018	11.0	13.2	27.9	41.1	14.7	10.2	13.9	-21.6	-$10,928	-6.0	-6.0
2019	11.0	13.2	33.6	46.8	14.9	12.0	13.0	-23.2	-$14,834	-8.7	-8.7
2020	11.0	13.2	33.0	46.2	11.2	12.8	12.9	-24.0	-$18,059	-10.2	-10.2
2021	11.0	13.2	32.5	45.7	11.8	12.4	14.1	-23.6	-$20,458	-10.5	-10.4
2022	11.0	13.2	37.1	50.3	15.0	13.5	13.8	-24.6	-$26,498	-12.7	-12.7
2023	11.0	13.2	37.9	51.1	10.8	13.4	12.9	-26.3	-$33,601	-15.1	-15.1
2024	11.0	13.2	35.9	49.1	10.2	13.5	13.5	-26.4	-$38,983	-16.0	-16.0
2025	11.0	13.2	37.8	51.0	12.6	13.6	13.8	-27.0	-$47,522	-17.5	-17.5
Aver-age	11.0	13.2	32.4	45.6	12.1	12.9	13.4	-23.2	-$19,949	-9.6	-9.6

1/ Figures for fiscal year 2013 are actuals.

root cause of this inconsistency. The continually rising gap also suggests the problem is intrinsic to the system so that securing additional foreign financing alone would not solve the problem.

Corresponding to the domestic saving-investment gap is a large disequilibrium in the external sector [Jayme JR, 2003 and Taylor, 1994]. The continued appreciation of the exchange rate in the baseline (Figure C4) is forecast to drag export growth down, which in turn depresses economic growth because of lower export spillover effects. Moreover, with lower export-spillovers, sustaining the 11 percent growth target has become more expensive because, given the sluggish productivity growth, the volume of investment required per unit of output as the economy grows gets higher. Table 3.17 shows that the total amount of investment required to achieve 11 percent growth reaches 51 percent of GDP by 2025. Imports are forecast to grow strongly driven by a robust GDP growth projection (Figure C2). Consequently, given exogenously forecast foreign savings, the foreign exchange gap is projected to widen to about USD 66.8 billion by 2025, which is 37.4 percent of GDP! As usual, because it is under direct control, the forecast shows government financing remaining comfortable and steady given the robust growth projection and the government's relatively low consumption expenditure (about 8.7 percent of GDP).

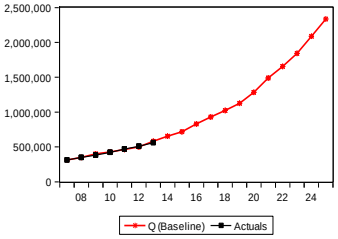
To conclude, the forecast widening of the saving-investment and foreign gaps suggest that attaining the forecast real GDP growth and inflation targets is not feasible. As constructed in the model, but also in reality, these gaps are binding constraints on the forecast growth and inflation targets. On the other hand, cutting investment is not the best option given the targeted growth and the country's vision to break the cycle of poverty. As the experience in the first three years of the GTP indicates, it looks possible to accelerate domestic savings with appropriate policies – refining and strengthening policies that have been used to accelerate domestic savings in the past.

Turning to the foreign exchange gap, two alternatives exist – foreign borrowing/capital transfers and boosting net exports. Increasing foreign borrowing is neither feasible nor desirable, for although Ethiopia is currently in the low debt distressed countries region, debt is growing rapidly, so that international capital markets

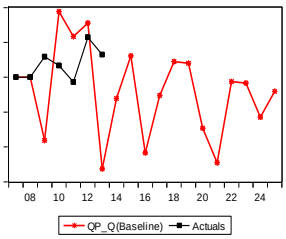
Figures 3-24: Baseline forecasts (2014 – 2025)

A. Goods and Services and Money Markets

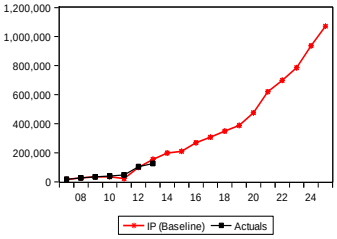
A1: REAL GDP (Q) :BASELINE



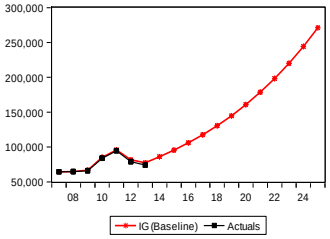
A2: DIFFERENCE BETWEEN POTENTIAL GDP AND ACTUAL GDP GROWTH (QP_Q): BASELINE FORECAST



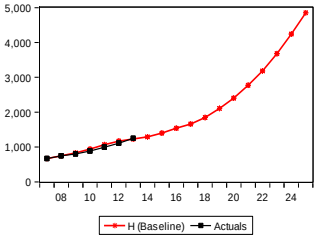
A3: REAL GROSS PRIVATE GROSS FIXED CAPITAL FORMATION (IP): BASELINE



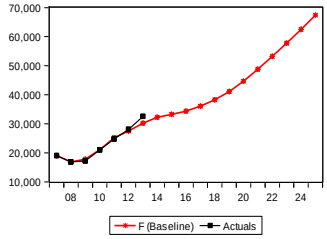
A4: REAL GROSS PUBLIC GROSS FIXED CAPITAL FORMATION (IG): BASELINE



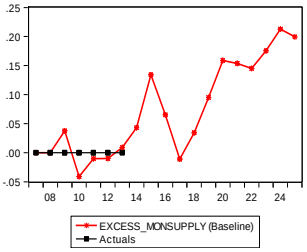
A5: HUMAND DEVELOPMENT INDEX (H): BASELINE



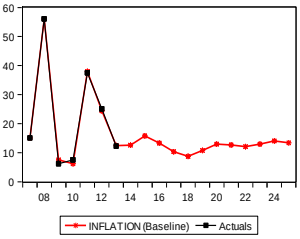
A6: REAL INFARSTRUCTURE OUTPUT (F): BASELINE



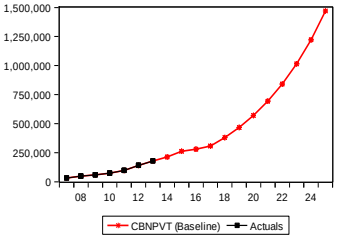
A7: EXCESS_MONSUPPLY: BASELINE



A8: INFLATION: BASELINE

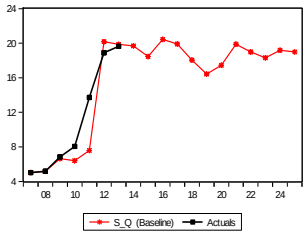


A9: COMMECIAL BANKS CLAIMS ON PRIVATE SECTOR (CBNPVT)

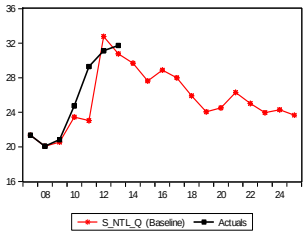


B Saving and Investment

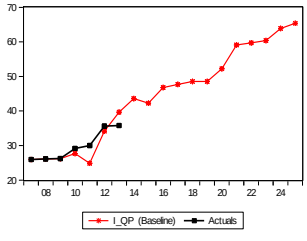
B1: GROSS DOMESTIC SAVINGS TO GDP RATIO (S_Q): BASELINE



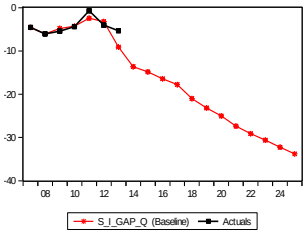
B2: GROSS NATIONAL SAVINGS TO GDP RATIO (S_NTL_Q): BASELINE



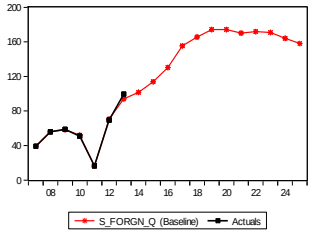
B3: GROSS TOTAL FIXED CAPITAL FORMATION TO GDP RATIO (I_QP): BASELINE



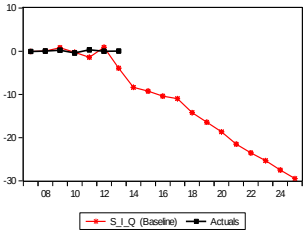
B4: SAVING-INVESTEMTN GAP TO GDP RATIO (S_I_GAP_Q) BEFORE FOREIGN SAVINGS: BASELINE



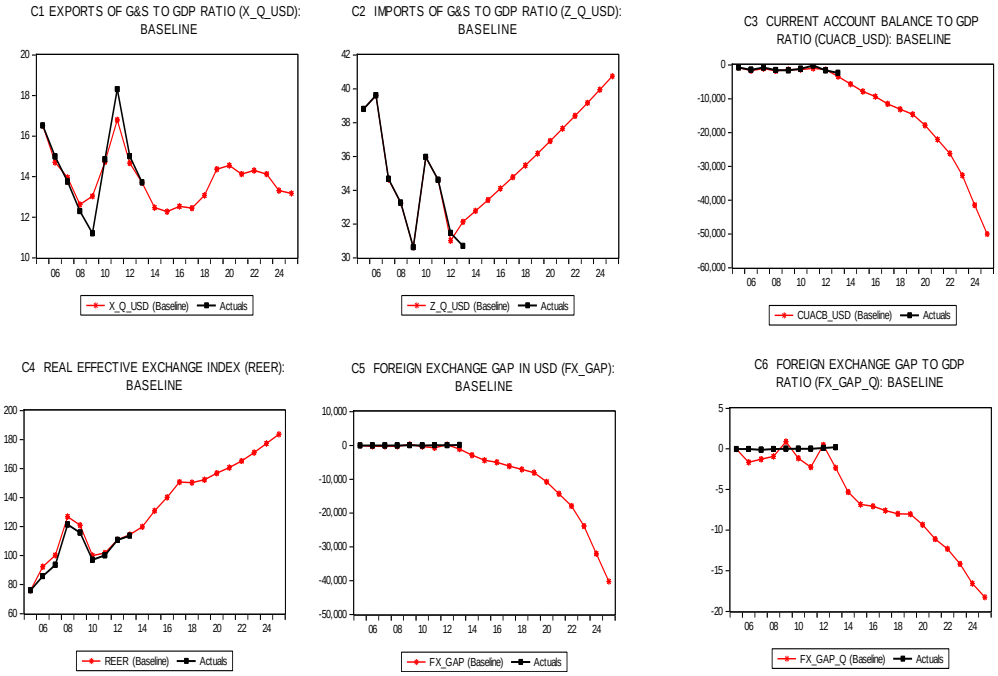
B5: FOREIGN SAVINGS TO GDP RATIO (S_FORGN_Q): BASELINE



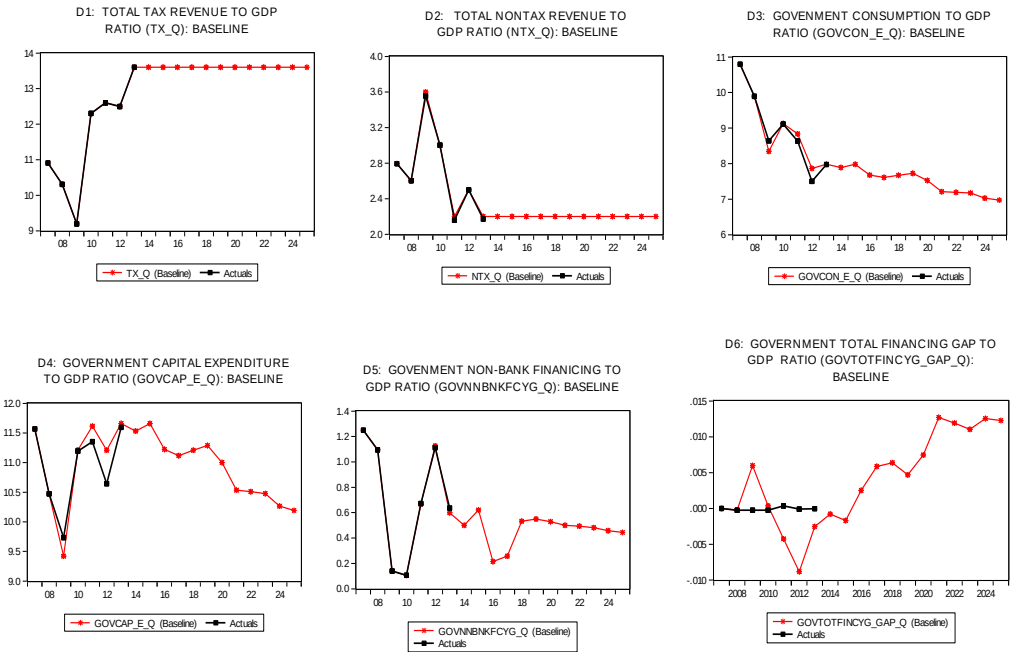
B6: SAVING-INVESTMENT TO GDP RATIO (S_I_Q) AFTER FOREIGN SAVINGS: BASELINE



C. External Sector



D. Government Sector



are unlikely to provide a major injection of funds. Moreover, the forecast of a continually increasing foreign exchange gap indicates that securing additional financing in the capital

market would only postpone the problem into the long-term by leading the debt burden to an unsustainable level. Hence attention must focus on the current account, about which two important issues are worth noting: export growth shows no sign of accelerating given the inflation-induced appreciation of the real exchange rate while, on the other hand, import growth shows no sign of abating given the strong growth projection. Overall, then, rethinking the policy options is unavoidable if Ethiopia is to achieve the plan targets and sustain growth in the long-term.

3.8.2.3 Simulation Exercise under Alternative Policy Measures

In the baseline scenario, it is observed that with widening saving-investment and foreign exchange gaps, the growth and inflation targets are not feasible, and need to be addressed. Therefore, this section runs some alternative policy simulation scenarios that are targeted to address the external and internal imbalances. The chapter considers the following six policy scenarios:

Scenario 1. Devaluing the Birr by 40 percent in 2014 from the Baseline.

Scenario 2. Raising domestic savings through a forced saving scheme. The long-run elasticity coefficient of disposable income is lowered by 0.04 points, from 1.0836 to 1.0436, in the private consumption function;

Scenario 3. Reducing the potential GDP growth target by 2 percentage points from 11 percent to 9 percent per year;

Scenario 4. Reducing the potential GDP growth target to 9 percent and devaluing the Birr by 20 percent;

Scenario 5. Reducing the base money supply by selling 30 percent of the central bank's financial asset holdings through Open Market Operation;

Scenario 6. Solving for the exchange rate path that brings the foreign exchange gap to zero.

Scenario I. Devaluation of the Birr by 40 percent by 2014 from the Baseline

The first policy simulation assumes a step devaluation of the Birr by 40 percent in 2014. As one of the main policy instruments in the external sector, and given the fact the baseline scenario indicates depressed export growth due to continual appreciation of the Birr in the forecast period, devaluation is considered as a key potential policy tool to address the external imbalance. The policy has dual objectives, as it also expected to have a positive impact on the saving-investment equilibrium through the current account of the balance of payments.

The immediate impact of a depreciation of the REER is to boost exports of goods and services. Exports of goods and services continually increase and reach 18.5 percent of GDP by 2025, from 13.5 percent in 2013. Compared with the baseline, the policy helps exports as a ratio of GDP to be 4.7 percentage points higher by 2025. Figure 3.25 (C2) also shows that imports-to-GDP has seen a one-time permanent upward step because now imports cost more in local currency compared with the baseline. Consequently, the current account has seen continuous improvement over the projection period and by the end of 2025, the average current account deficit has shrunk by more than USD 10 billion from USD19.9 billion (in the baseline forecast) to USD 9.8 billion (Table 3.18). Improvement in the current account balance has turned the foreign exchange gap positive in the first five years of the projection period (2014-2018) and lower deficits in the rest of the years compared with the baseline – Figures 3-25. Overall, the foreign exchange gap is significantly narrowed to an annual average of 1.4 of percent of GDP compared with 9.6 percent in the baseline. The deficit appears to be financeable; however, as the annual deficit is forecast to widen as much as 10 percent of GDP by 2025, the country needs to save the surpluses of the first five years so that it can use them in the deficit years.

In the goods and money markets, the spillover from the higher rate of growth of exports compared with the baseline reduces the required level of investment per unit of output. As a result, annual average total investment as percentage of GDP declines by 2.3 percentage points, from 45.6 percent to 43.3 percent despite the increase in aggregate

Table 3-18: Simulation Results Assuming a 40 Percent Devaluation of the Birr (for Selected Goods Market, Money Market and External Sector Variables: 2014 – 2025[1/])

	Long-term Out-put Grow-th Target (gT)	Investment Requirement					Short-Run Aggregate Supply Growth (Q%)		Inflation		External Sector						Saving-Investment Gap (S_I_Q)	
		Public Investment Requirement (IG_Q)	Private Sector Investment Requirement (% GDP) (IP_Q)		Total Investment Requirement (% GDP) (I_Q)						Export of G&S (% GDP) (X_USD_Q)		Current Account Balance (in Millions of USD) (CUACB_USD)		Foreign Exchange Gap (% GDP) (FX_GAP_Q)			
	Target	Policy	Bs	Sc1	Bs	Sc1	Bs	Sc1	Bs	Sc1	Bs	Sc1	Bs	Sc1	Bs	Sc1	Bs	Sc1
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2013	11.0	13.2	22.6	22.6	35.8	35.8	9.7	17.1	12.3	12.3	13.7	13.7	-$2,346.0	-$2,346.0	0.2	0.2	0.0	-2.7
2014	11.0	13.2	20.7	22.0	37.4	39.4	12.0	15.4	13.3	11.8	14.8	24.6	-$3,573.0	$2,125.0	-1.6	13.7	-1.6	-0.4
2015	11.0	13.2	26.2	23.1	44.3	41.1	14.9	14.6	16.8	15.2	13.8	17.5	-$6,294.0	-$1,876.0	-4.7	3.5	-4.7	-0.6
2016	11.0	13.2	27.0	24.9	44.9	43.1	11.2	11.7	13.4	13.6	12.0	14.4	-$9,004.0	-$4,166.0	-6.9	0.3	-6.9	-2.8
2017	11.0	13.2	23.7	23.2	39.7	40.1	6.1	7.8	9.5	6.9	12.4	13.9	-$9,638.0	-$4,484.0	-5.9	1.8	-5.9	-3.5
2018	11.0	13.2	24.6	21.8	41.1	38.6	14.7	12.6	10.2	9.5	13.9	16.7	-$10,928.0	-$4,577.0	-6.0	2.3	-6.0	-2.4
2019	11.0	13.2	28.8	25.6	46.8	44.2	14.9	16.8	12.0	12.4	13.0	15.8	-$14,834.0	-$7,302.0	-8.7	-1.2	-8.7	-3.7
2020	11.0	13.2	28.5	27.2	46.2	46.2	11.2	11.8	12.8	13.8	12.9	15.3	-$18,059.0	-$9,604.0	-10.2	-3.2	-10.2	-6.7
2021	11.0	13.2	28.1	24.6	45.7	42.4	11.8	9.6	12.4	12.3	14.1	17.9	-$20,458.0	-$9,727.0	-10.5	-2.3	-10.4	-6.7
2022	11.0	13.2	31.3	25.8	50.3	44.5	15.0	14.2	13.5	13.8	13.8	18.4	-$26,498.0	-$12,924.0	-12.7	-4.4	-12.7	-7.5
2023	11.0	13.2	32.2	28.6	51.1	48.1	10.8	12.4	13.4	13.8	12.9	16.8	-$33,601.0	-$18,289.0	-15.1	-7.9	-15.1	-11.2
2024	11.0	13.2	30.8	27.5	49.1	46.0	10.2	9.0	13.5	14.2	13.5	17.9	-$38,983.0	-$20,974.0	-16.0	-8.6	-16.0	-13.2
2025	11.0	13.2	32.2	27.3	51.0	45.9	12.6	11.7	13.6	14.4	13.8	18.4	-$47,522.0	-$26,101.0	-17.5	-10.3	-17.5	-14.4
Aver-age	11.0	13.2	27.8	25.1	45.6	43.3	12.1	12.3	12.9	12.6	13.4	17.3	-$19,949.3	-$9,824.9	-9.6	-1.4	-9.6	-6.1

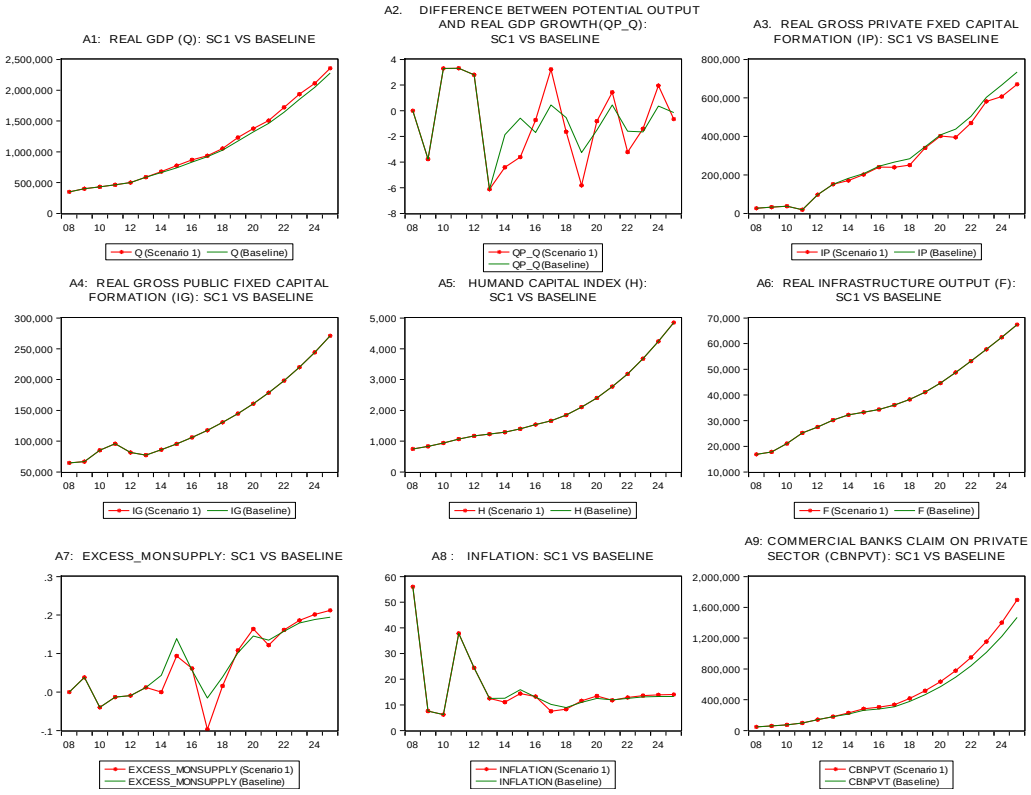
1/ Figures for fiscal year 2013 are actuals, and the 40 Percent Devaluation of the Birr is computed from the Baseline

supply compared with the baseline (Table 3.18 and Figures 3-25(A1) and (A3)). The boom in exports and improved balance in the money markets feed through into an actual GDP, which rises above baseline levels – showing annual average growth of 12.9 percent compared with 12.3 percent in the baseline (Table 3.18 and Figures 3-25(A1) and (A2)). In steady state, of course, it will be constrained to fall back onto potential GDP, for which we have imposed target growth of 11 percent per year, but the projections, as well the actual economy, display dynamics that allow deviations to persist for some time.

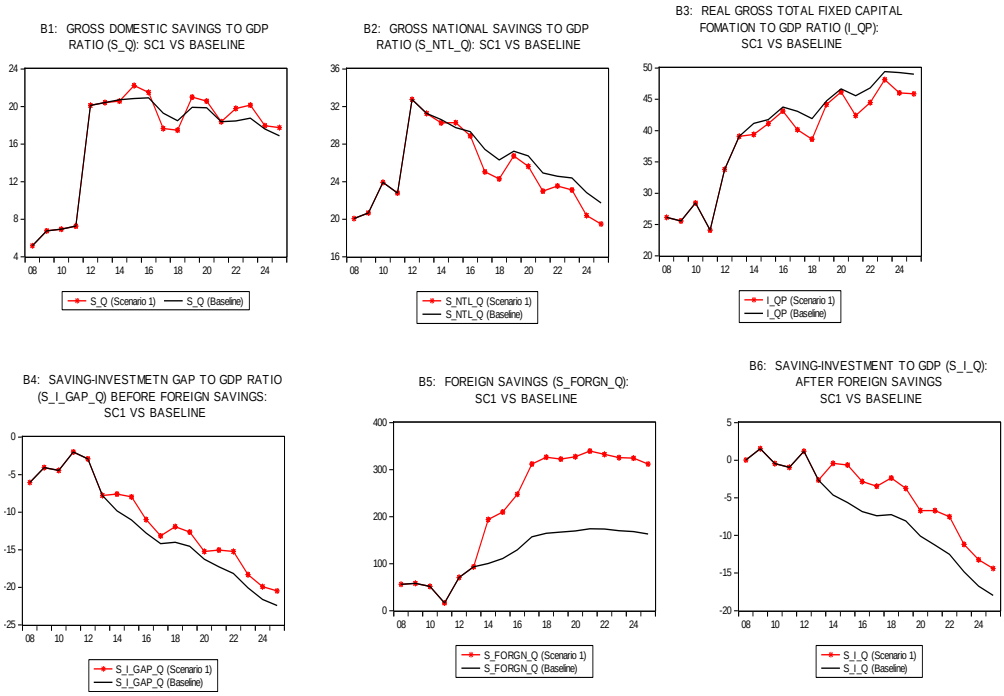
The increase in the demand for money as a result of higher growth and the depreciated exchange rate lead the money market disequilibrium (Figure 3-25(A7)) to improve in the first five years until 2018, offsetting the effect devaluation on the money supply. Therefore, inflation is forecast to show a moderate decline compared with the baseline. It looks counterintuitive to see a major devaluation followed by a decline in inflation. However, for the following reasons it happened in Ethiopia in 1993 after a 144 percent devaluation in Birr terms, and after the frequent adjustments in the value of the Birr in 2009 and 2010. When the exchange rate appreciates, exports decline and the foreign exchange market faces major shortage. This results in a widening gap between the official and parallel market exchange rates. And, prices, particularly prices of imported goods, usually adjust to the parallel market exchange rate. So, devaluation begins to affect the prices of imports directly when the rate of devaluation exceeds the gap between the parallel and official exchange rate. Secondly, the devaluation increases the demand for money, as people need to hold more money per unit of foreign currency for transaction purposes. The third reason is that as devaluation increases exports, it eases the foreign exchange constraint and hence boosts the supply of importable goods. In fact, the latter may push prices further down by narrowing the supply gap premium in the goods market. For instance, after the first major devaluation in 1993, inflation dropped to 7.7 in 1993 from 21.9 percent in 1992. Similarly, after a cumulative depreciation of the Birr by more than 40 percent in 2009 and 2010, inflation subsided from 34.2 percent in 2009 to 5.2 percent in 2010.

Figures 3-25: Effects of a 40 Percent Devaluation of the Birr in 2015

A. Goods and Services and Money Market

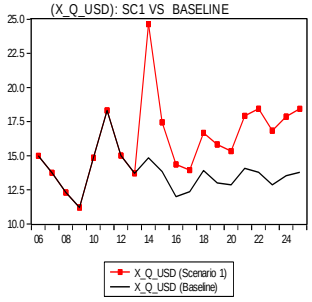


B. Saving and Investment

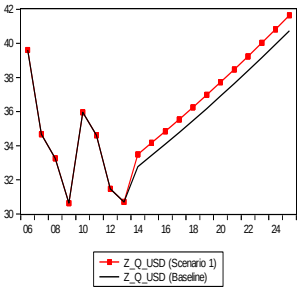


C. External Sector

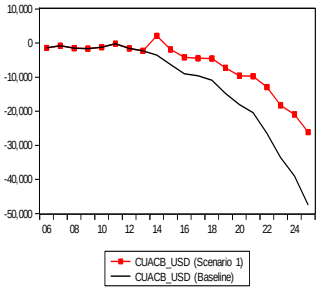
C1 EXPORTS OF G&S TO GDP RATIO (X_Q_USD): SC1 VS BASELINE



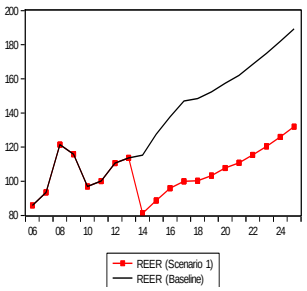
C2 IMPORTS OF G&S TO GDP RATIO (Z_Q_USD): SC1 VS BASELINE



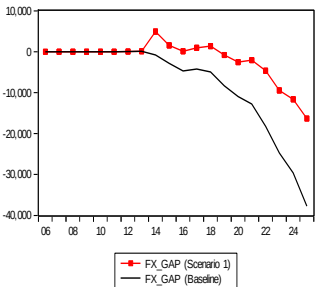
C3 CURRENT ACCOUNT BALANCE IN USD (CUACB_USD): SC1 VS BASLELINE



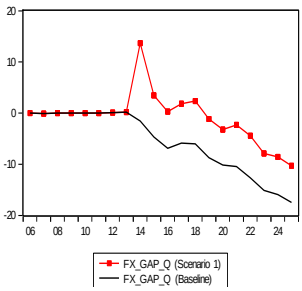
C4 REAL EFFECTIVE EXCHANGE RATE INDEX (REER): SC1 VS BASELINE



C5 FOREIGN EXCHANGE GAP IN USD (FX_GAP): SC1 VS BASELINE

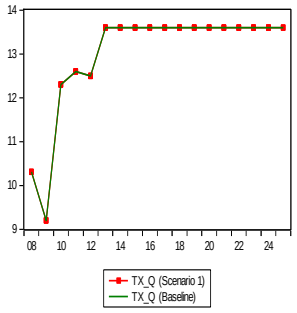


C6 FOREIGN EXCHANGE GAP TO GDP RATIO (FX_GAP_Q): SC1 VS BASELINE

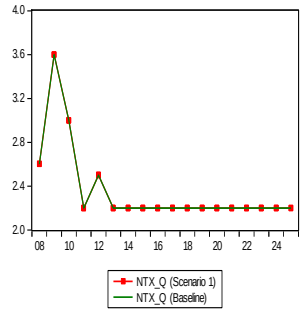


D. Government Sector

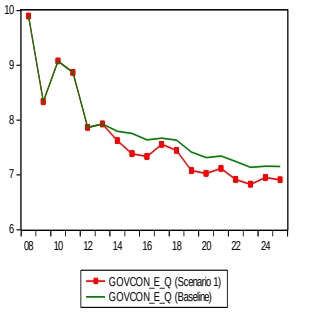
D1: TOTAL TAX REVENUE TO GDP RATIO (TX_Q): SC1 VS BASELINE



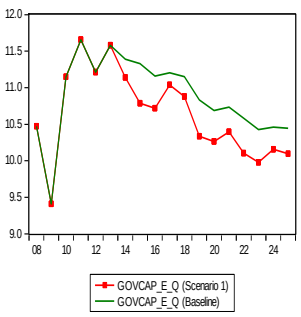
D2: NON-TAX REVENUE TO GDP RATIO (NTX_Q): SC1 BASELINE



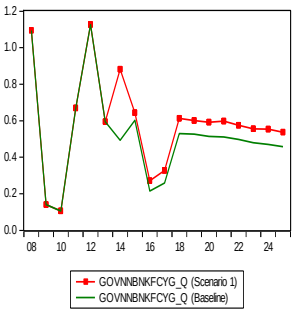
D3: GOVERNMNET CONSUMPTION EXPENDITURE TO GDP RATIO (GOVCON_E_Q): SC1 VS BASELINE



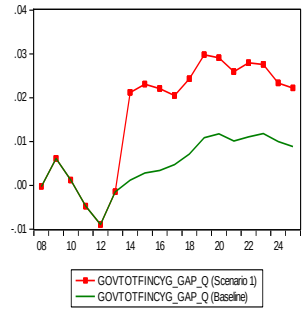
D4: GOVERNMENT CAPITAL EXPENDITURE TO GDP RATIO (GOVCAP_E_Q): SC1 VS BASELINE



D5: NONBANK FINANCING TO GDP RATIO (GOVNNBNKFCYG_Q): SC1 VS BASELINE



D6: TOTAL GOVERNMENT FINANCING GAP TO GDP RTIO (GOVTOTFINCYG_GAP_Q): SC1 VS BASELINE



Reflecting improvements in the current account, the saving-investment balance (Figure B6) shows a moderate improvement. The average saving-investment gap is narrowed from 9.6 percent in the baseline to 6.1 percent of GDP (Table 3.18, column 17 and 18). However, the deficit is still not sustainable.

In the government sector, consumption and capital expenditure as a ratio of GDP decline compared with the baseline (Figure 3-25(D3) and (D4)) because of the higher denominator, i.e, the higher than baseline GDP. The demand for government securities by the non-bank public is forecast to rise as the latter feel wealthier due to increased flow of income from exports (Figure 3-25(D5)). As a result, the government-financing surplus shows a sharp rise, reaching close to 3 percent of GDP by 2020 (Figure 3-25(D6)).

To conclude, devaluation of the Birr seems to be an effective policy instrument in addressing problems related to the resource gaps, i.e., foreign exchange and saving-investment gaps if it is cautiously implemented to avoid under- or over-shooting of the intended results.

Scenario II. Raising domestic savings through forced saving scheme. The long-run elasticity coefficient of disposable income is lowered by 0.04 points, from 1.0836 to 1.0436, in the private consumption function.

The results of this simulation are presented in Table 3-19 and Figures 3-26. As expectated gross domestic savings and gross national savings show improvements as ratios of GDP (Figures 3-26(B1) and (B2)). These changes are reflected in the foreign exhange and the saving-investment gaps but are slightly moderated by an increase in the ratio of total investment to GDP and an unchanged import-to-GDP ratio compared with the baseline (Figure 3-26(C2)). Because the gaps adjust to absorb the change in savings, the effects on the rest of the economy are negligible. Thus the policy has little impact on the goods and money markets, except on acutal GDP growth which declines from 12.1 percent in the baseline to 11.8 percent on average (Figures 3-26(A1) to (A9)).

In government sector, as expected, consumption and capital expenditure increase as a ratio of GDP compared withthe baseline. This is because, as they are policy determined

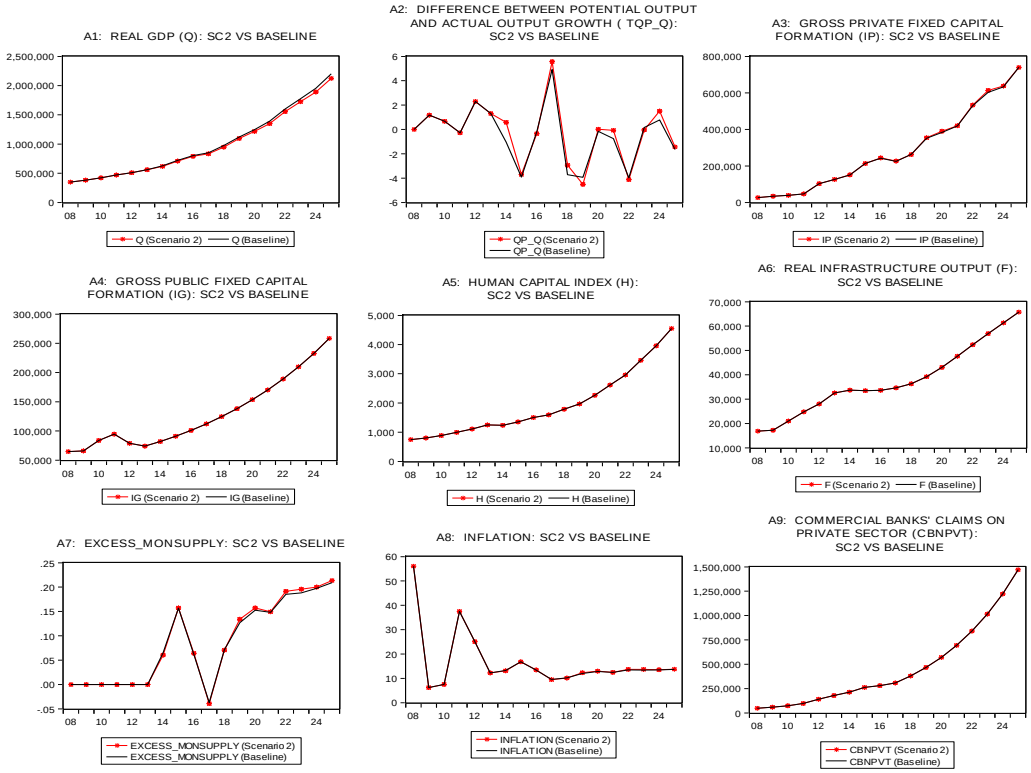
Table 3-19:Forecast Simulation Results Assuming a Forced Saving: 2014-2025

	Long-term Output Growth Target (gT)	Investment Requirement					Short-Run Aggregate Supply Growth (Q%)		Inflation		External Sector						Saving-Investment Gap (S_I_Q)	
		Public Investment Requirment (IG_Q)	Private Sector Investment Requirement (% GDP) (IP_Q)		Total Investment Requirement (% GDP) (I_Q)						Export of G&S (% GDP) (X_USD_Q)		Current Account Balance (in Millions of USD) (CUACB_USD)		Foreign Exchange Gap (% GDP) (FX_GAP_Q)			
	Target	Policy	Bs	Sc2	Bs	Sc2	Bs	Sc2	Bs	Sc2	Bs	Sc2	Bs	Sc2	Bs	Sc2	Bs	Sc2
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2013	11.0	13.2	22.6	22.6	35.8	35.8	9.7	9.7	12.3	12.3	13.7	13.7	-$2,346	-$2,346	0.2	0.2	0.0	0.0
2014	12.0	13.2	24.2	24.3	37.4	37.5	12.0	10.4	13.3	13.1	14.8	14.8	-$3,573	-$3,443	-1.6	-1.3	-1.6	-1.3
2015	13.0	13.2	31.1	31.0	44.3	44.2	14.9	14.7	16.8	16.8	13.8	14.0	-$6,294	-$5,977	-4.7	-4.2	-4.7	-4.2
2016	14.0	13.2	31.7	31.9	44.9	45.1	11.2	11.3	13.4	13.4	12.0	12.0	-$9,004	-$8,759	-6.9	-6.7	-6.9	-6.7
2017	15.0	13.2	26.5	26.7	39.7	39.9	6.1	5.4	9.5	9.5	12.4	12.2	-$9,638	-$9,372	-5.9	-5.6	-5.9	-5.6
2018	16.0	13.2	27.9	27.9	41.1	41.1	14.7	13.9	10.2	10.1	13.9	13.9	-$10,928	-$10,396	-6.0	-5.5	-6.0	-5.5
2019	17.0	13.2	33.6	33.9	46.8	47.1	14.9	15.5	12.0	12.3	13.0	13.0	-$14,834	-$14,319	-8.7	-8.4	-8.7	-8.3
2020	18.0	13.2	33.0	33.6	46.2	46.8	11.2	11.0	12.8	13.0	12.9	12.6	-$18,059	-$17,729	-10.2	-10.1	-10.2	-10.1
2021	19.0	13.2	32.5	32.6	45.7	45.8	11.8	11.1	12.4	12.5	14.1	13.9	-$20,458	-$19,836	-10.5	-10.2	-10.4	-10.2
2022	20.0	13.2	37.1	37.3	50.3	50.5	15.0	15.1	13.5	13.7	13.8	13.8	-$26,498	-$25,560	-12.7	-12.3	-12.7	-12.3
2023	21.0	13.2	37.9	38.6	51.1	51.8	10.8	11.0	13.4	13.6	12.9	12.7	-$33,601	-$32,899	-15.1	-15.0	-15.1	-15.0
2024	22.0	13.2	35.9	36.2	49.1	49.4	10.2	9.5	13.5	13.5	13.5	13.3	-$38,983	-$37,992	-16.0	-15.9	-16.0	-15.9
2025	23.0	13.2	37.8	37.8	51.0	51.0	12.6	12.4	13.6	13.8	13.8	13.8	-$47,522	-$45,793	-17.5	-17.2	-17.5	-17.2
Aver-age	17.5	13.2	32.4	32.6	45.6	45.8	12.1	11.8	12.9	12.9	13.4	13.3	-$19,949	-$19,340	-9.6	-9.4	-9.6	-9.4

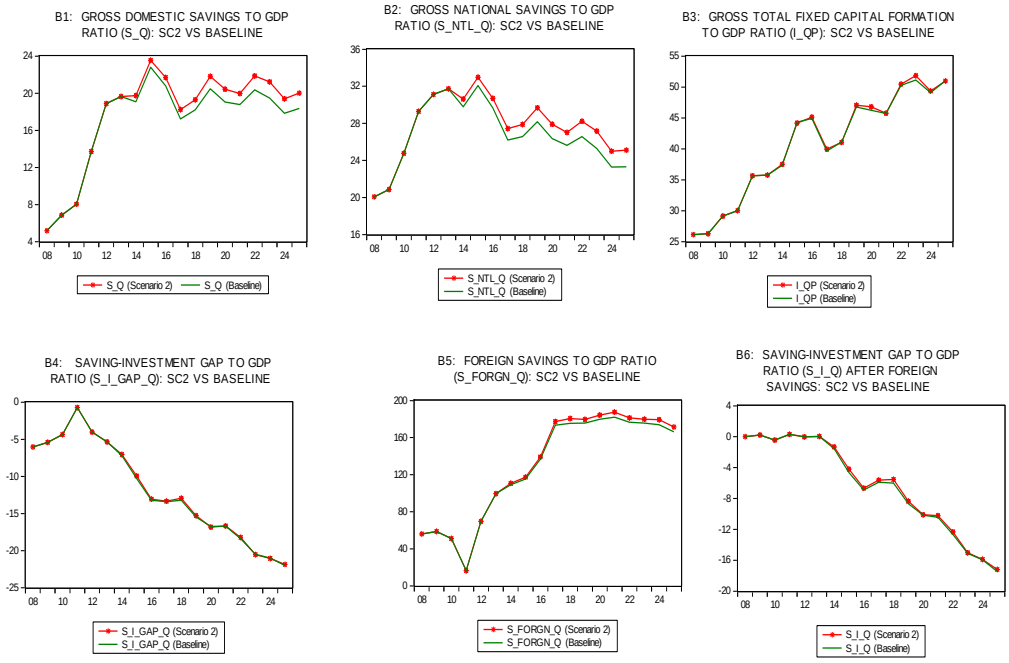
Note: figures for fiscal year 2013 are actuals.

Figures 3-26: Effects of Government Forced Savings Measures

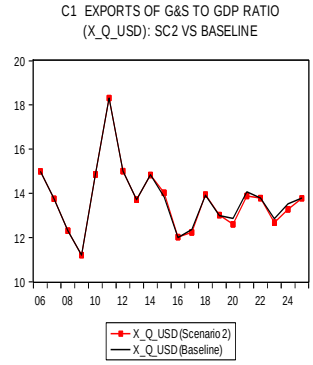
A Goods and Services and Money Market

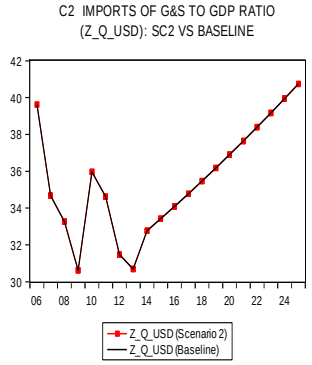


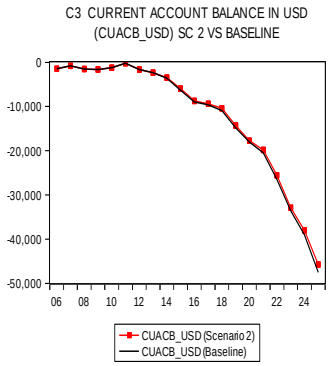
B. Saving and Investment

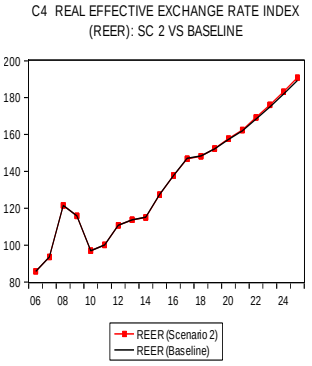


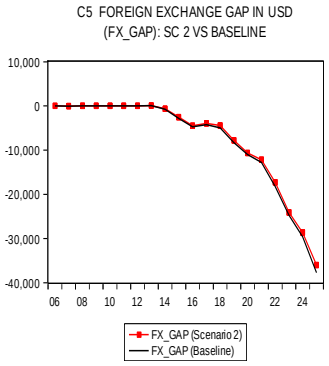
C. External Sector

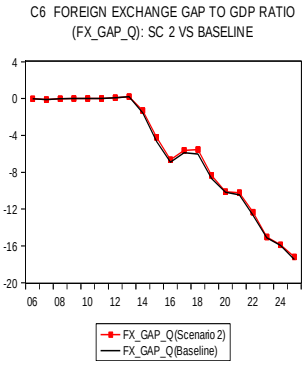




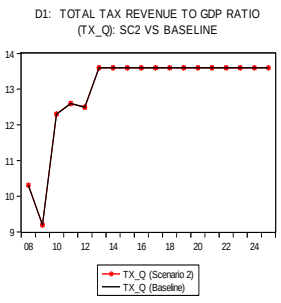


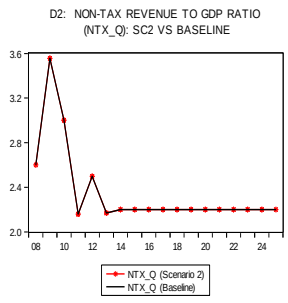


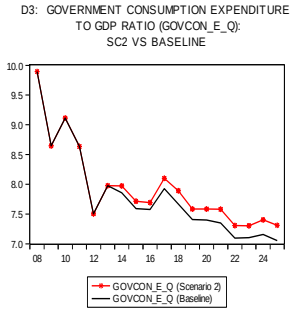


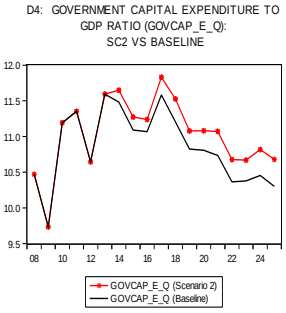


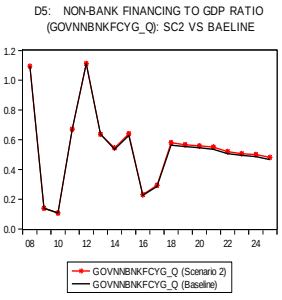
D. Government Sector

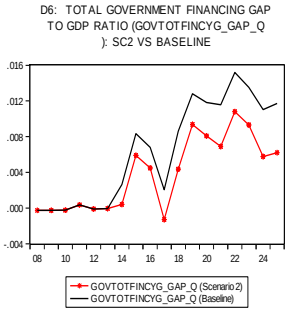












variables, their values remain unchanged in absolut terms but, as a ratio of a lower GDP compared withthe baseline, their relative values show moderate improvement resulting in lower governemnt surplus than the baseline.

To conclude, in the context of a Financial Programming exercise this policy does not bring the intended improvements in the goods and money markets. However, because it eliminates some of the financing gaps, combining it with other policies may help to redress imbalances that would otherwise curtail real economic improvements. Also, of course, one must recognise that intrioducing an effective forced savings will pose challenges in and of itself.

Scenario III. Assuming that Potential Growth Target is Cut Back by Two Percentage Points from 11 Percent to 9 Percent

Lowering long-term growth rate by 2 percentage points is found to have the expected positive impact in redressing internal and external disequilibrium – see Table 3-20. Exports as a ratio of GDP are forecast to decline marginally to 13.1 percent from 13.4 percent in the baseline because of the appreciation of the real effective exchange rate compared with the baseline, which in turn arises because average annual inflation eases up from 12.9 percent to 13.2 percent per annum. However, the significant drop imports in absolute terms following a 2.4 percentage drop in annual average GDP growth, from 12.1 percent in the baseline to 9.7 percent more than offsets the decline in exports and leads to an improvement the current account deficit that goes down from USD 19.9 billion in the baseline to USD 15.8 billion (Table 3.20). Moreover, private investment demand as a ratio of GDP declines from 32.4 percent in the baseline to 28.1 percent, in the simulation because a lower potential growth target entails a lower investment need.

Parallel to the improvement in the current account balance, the gaps in the foreign exchange and saving-investment balances go down by 1.7 percentage points each – see Table 3-20, columns (15)-(18) and Figures 3-27(B6) and (C6). It is worth noting that the saving-investment gap is the direct reflection of foreign exchange gap in the absence of exchange rate policy as the relative price of tradable to non-tradable remains unaffected. This is clear from a comparison of the simulation results from scenarios 1 and 4 against scenarios 2, 3 and 5. In the government sector, although consumption and capital expenditures have not changed in absolute terms, their values as a ratio of GDP have declined resulting in a lower surplus in government financing as a ratio of GDP.

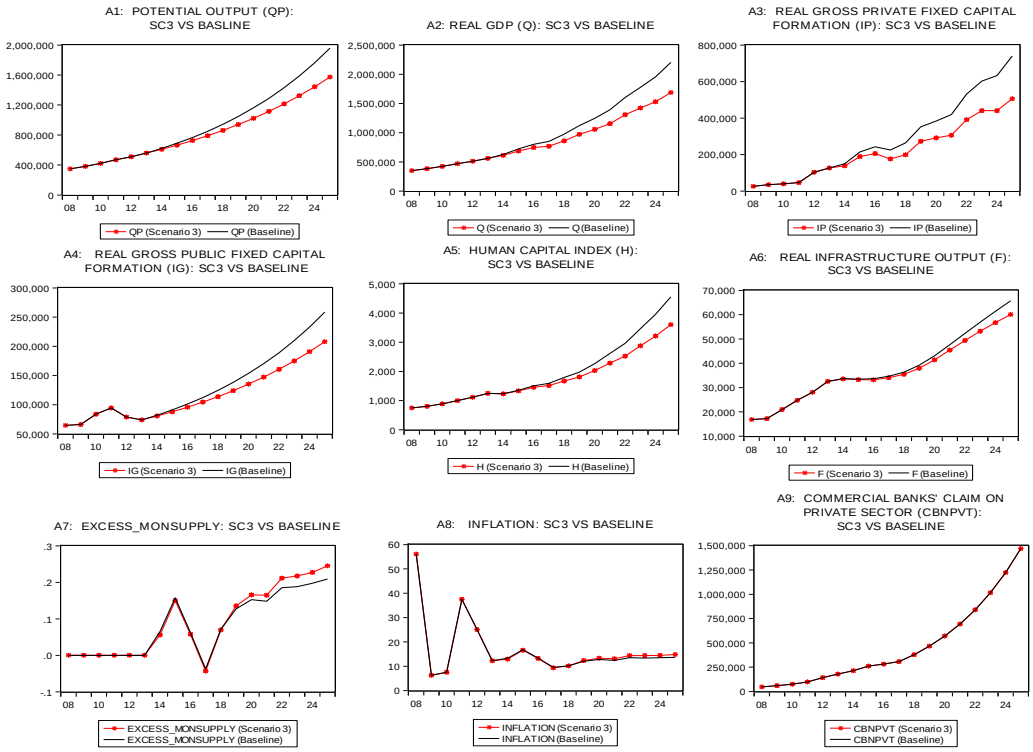
Table 3-20: Forecast Simulation Results Assuming 9 percent Potential Growth Target

	Long-term Output Growth Target (gT)	Investment Requirement						Short-Run Aggregate Supply Growth (Q%)		Inflation		External Sector						Saving-Investment Gap (S_I_Q)	
		Public Investment Requirement (IG_Q)		Private Sector Investment Requirement (% GDP) (IP_Q)		Total Investment Requirement (% GDP) (I_Q)						Export of G&S (% GDP) (X_USD_Q)		Current Account Balance (in Millions of USD) (CUACB_USD)		Foreign Exchange Gap (% GDP) (FX_GAP_Q)			
	Target	Policy		Bs	Sc.3	Bs	Sc.3	Bs	Sc.3	Bs	Sc.3	Bs	Sc.3	Bs	Sc.3	Bs	Sc.3	Bs	Sc.3
	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2013	11.0	13.2		22.6	22.6	35.8	35.8	9.7	9.7	12.3	12.3	13.7	13.7	-$2,346.0	-$2,346.0	0.2	0.2	0.0	0.0
2014	9.0	13.2		24.2	22.6	37.4	35.8	12.0	9.0	13.3	12.9	14.8	14.8	-$3,573.0	-$3,328.0	-1.6	-1.1	-1.6	-1.1
2015	9.0	13.2		31.1	28.4	44.3	41.6	14.9	12.3	16.8	16.6	13.8	14.2	-$6,294.0	-$5,479.0	-4.7	-3.5	-4.7	-3.5
2016	9.0	13.2		31.7	28.4	44.9	41.6	11.2	8.6	13.4	13.2	12.0	12.2	-$9,004.0	-$7,731.0	-6.9	-5.5	-6.9	-5.4
2017	9.0	13.2		26.5	22.3	39.7	35.5	6.1	3.1	9.5	9.4	12.4	12.4	-$9,638.0	-$7,973.0	-5.9	-4.0	-5.9	-4.0
2018	9.0	13.2		27.9	23.1	41.1	36.3	14.7	12.0	10.2	10.1	13.9	14.0	-$10,928.0	-$8,679.0	-6.0	-3.8	-6.0	-3.8
2019	9.0	13.2		33.6	29.1	46.8	42.3	14.9	13.1	12.0	12.4	13.0	12.9	-$14,834.0	-$11,918.0	-8.7	-6.5	-8.7	-6.5
2020	9.0	13.2		33.0	28.5	46.2	41.7	11.2	8.8	12.8	13.3	12.9	12.4	-$18,059.0	-$14,561.0	-10.2	-8.2	-10.2	-8.2
2021	9.0	13.2		32.5	27.4	45.7	40.6	11.8	9.1	12.4	13.0	14.1	13.5	-$20,458.0	-$16,174.0	-10.5	-8.4	-10.4	-8.4
2022	9.0	13.2		37.1	32.1	50.3	45.3	15.0	13.1	13.5	14.4	13.8	13.2	-$26,498.0	-$20,885.0	-12.7	-10.7	-12.7	-10.7
2023	9.0	13.2		37.9	33.2	51.1	46.4	10.8	8.9	13.4	14.4	12.9	12.0	-$33,601.0	-$26,571.0	-15.1	-13.3	-15.1	-13.3
2024	9.0	13.2		35.9	30.5	49.1	43.7	10.2	7.5	13.5	14.4	13.5	12.6	-$38,983.0	-$30,352.0	-16.0	-14.2	-16.0	-14.2
2025	9.0	13.2		37.8	32.1	51.0	45.3	12.6	10.5	13.6	14.8	13.8	13.0	-$47,522.0	-$36,460.0	-17.5	-15.7	-17.5	-15.7
Aver-age	9.0	13.2		32.4	28.1	45.6	41.3	12.1	9.7	12.9	13.2	13.4	13.1	-$19,949.3	-$15,842.6	-9.6	-7.9	-9.6	-7.9

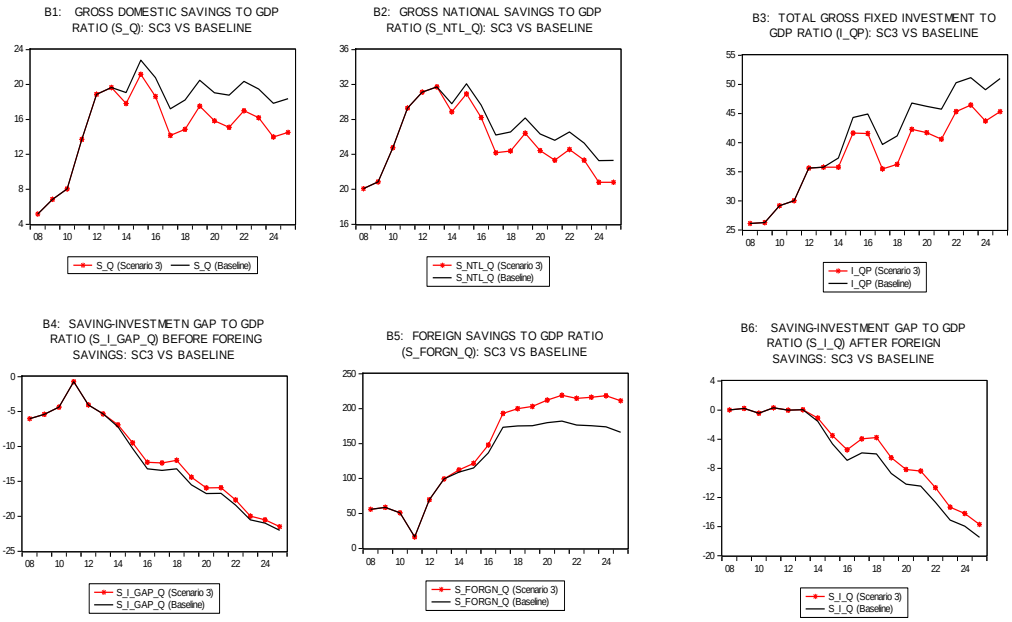
1/ Figures for fiscal year 2013 are actuals

Figures 3-27: Effects of Lowering Potential Growth Assumption to 9 percent

A. Goods and Services and Money Market

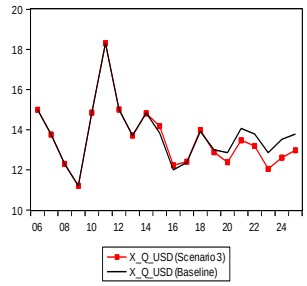


B. Saving and Investment

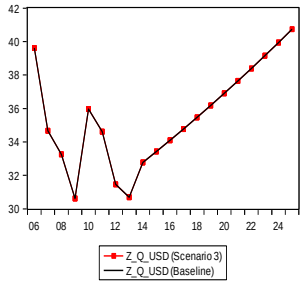


C. External Sector

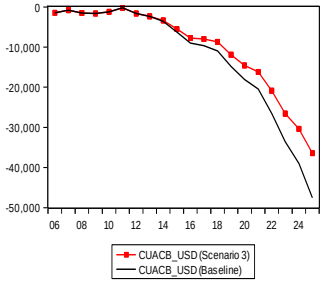
C1 EXPORTS OF G&S TO GDP RATIO (X_Q_USD): SC 3 VS BASELINE



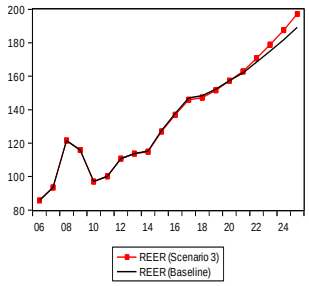
C2 IMPORTS OF G&S TO GDP RATIO (Z_Q_USD): SC 3 VS BASELINE



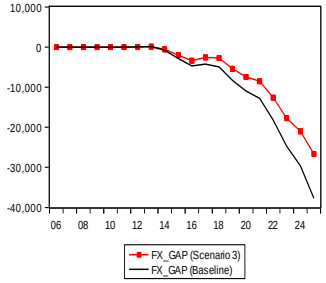
C3 CURRENT ACCOUNT BALANCE IN USD (CUACB_USD): SC3 VS BASELINE



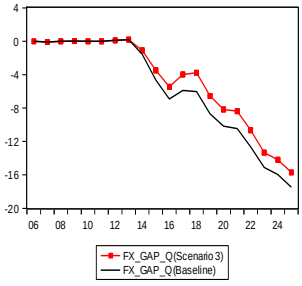
C4 REAL EFFECTIVE EXCHANGE RATE INDEX (REER): SC 3 VS BASELINE



C5 FOREIGN EXCHANGE GAP IN USD (FX_GAP): SC 3 VS BASELINE

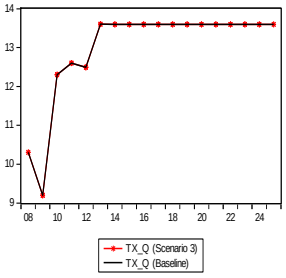


C6 FOREIGN EXCHANGE GAP TO GDP RATIO (FX_GAP_Q): SC 3 VS BASELINE

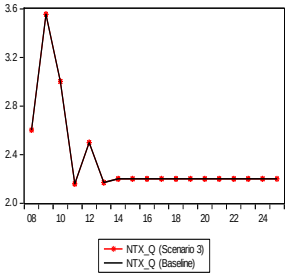


D. Government Sector

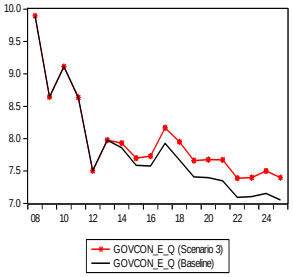
D1: TOTAL TAX RAVENUE TO GDP RATIO (TX_Q): SC3 VS BASELINE



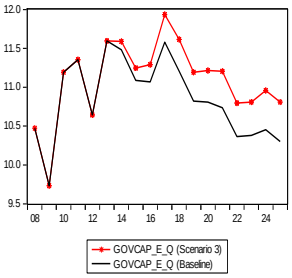
D2: NON-TAX REVENUE TO GDP RATIO (NTX_Q): SC3 VS BASELINE



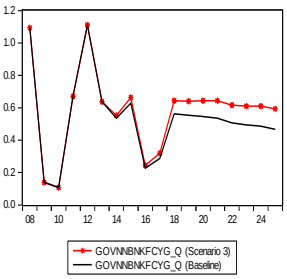
D3: GOVERNMENT CONSUMPTION EXPENDITURE TO GDP RATIO (GOVCON_E_Q): SC3 VS BASELINE



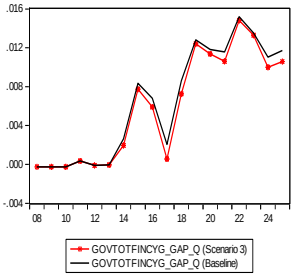
D4: GOVERNMENT CAPITAL EXPENDITURE TO GDP RATIO (GOVCAP_E_Q): SC3 VS BASELINE



D5: NON-BANK FINANCING TO GDP RATIO (GOVNNBNKFCYG_Q): SC3 VS BASELINE



D6: TOTAL GOVERNMENT FINANCING GAP TO GDP RATIO (GOVTOTFINCYG_GAP_Q): SC3 VS BASELINE



Scenario IV. Assuming Potential Growth is Two Percentage Points lower than the Baseline (Similar to Scenario 3) and Devaluation of the Birr by 20 percent in 2014

This scenario combines a reduction in domestic aggregate demand by assuming a 2 percentage point lower potential output growth (i.e. scenario 3) with the scenario which assumes a relative price adjustment in favor of the tradable sector by devaluing the Birr (scenario 1, but this time only 20 percent devaluation). As shown in Table 3.21, the current account deficit shows significant improvement compared with not only the baseline but also with scenario 3. As average exports increase from 13.4 percent to 15.2 percent of GDP, the annual average current account deficit declines from USD 19.9 billion to 11.1 billion. Consequently, the annual average foreign exchange gap declines from 9.6 percent to 3.6 percent as a ratio of GDP while the saving-investment gap narrows to 3.0 percent from 9.6 percent in the baseline. The latter indicates significant improvements compared with both the baseline and scenario 3 (Table 3.20 and 3.21).

In the goods market, the decline in the total investment to GDP ratio is stronger compared with scenario 3, when only lowering potential GDP growth is assumed (Tables 3.20 and 3.21). In this scenario, the boost in export growth following the relative price shift in favor of tradable goods stimulates output growth because the higher spillover effects from the export sector offset part of the decline in the demand for physical capital formation. In the government sector, current and capital expenditure to GDP ratios increase similar to scenario 3. However, this time the demand for government securities sees a significant rise compared with both the baseline and scenario 3 because of higher wealth following improvement in the export sector (Figure 3-28(D5)). Consequently, the government-financing surplus experiences a dramatic upward shift (Figure 3-28(D6)). To conclude, combining scenario 3 and exchange rate adjustment produces better results than both scenario I and scenario III. Under scenario I, the 40 percent devaluation produces lower current account deficit as percentage of GDP but the reduction in savings-investment gap remains moderate due to still higher domestic investment demand compared to the current scenario. On the other hand, compared with the current scenario, lower reductions in current account deficit and saving-investment gap are registered under scenario III by cutting growth target to 9 percent. This suggests that

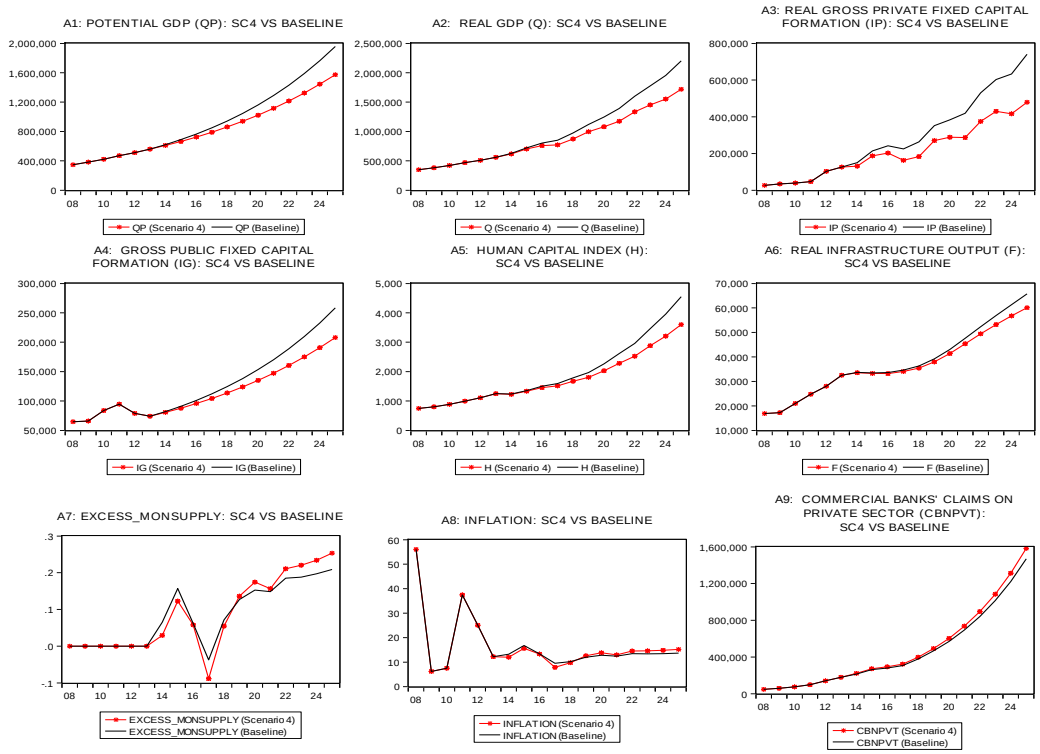
Table 3-21: Simulation Forecast Results Assuming 9 Percent Growth and 20 Percent Devaluation

	Long-term Output Growth Target (gT)	Investment Requirement					Short-Run Aggregate Supply Growth (Q%)		Inflation		External Sector						Saving-Investment Gap (S_I_Q)	
		Public Invest-mentRequirement (IG_Q)	Private Sector Investment Requirement (% GDP) (IP_Q)		Total Investment Requirement (% GDP) (I_Q)						Export of G&S (% GDP) (X_USD_Q)		Current Account Balance (in Millions of USD) (CUACB_USD)		Foreign Exchange Gap (% GDP) (FX_GAP_Q)			
	Target	Policy	Bs	Sc.4	Bs	Sc.4	Bs	Sc.4	Bs	Sc.4	Bs	Sc.4	Bs	Sc.4	Bs	Sc.4	Bs	Sc.4
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2013	11.0	13.2	22.6	22.6	35.8	35.8	9.7	9.7	12.3	12.3	13.7	13.7	-$2,346	-$2,346	0.2	0.2	0.0	0.0
2014	9.0	13.2	24.2	21.6	37.4	34.8	12.0	10.4	13.3	12.0	14.8	22.8	-$3,573	$977	-1.6	9.3	-1.6	3.6
2015	9.0	13.2	31.1	28.1	44.3	41.3	14.9	13.9	16.8	15.6	13.8	16.0	-$6,294	-$3,265	-4.7	0.4	-4.7	1.4
2016	9.0	13.2	31.7	28.0	44.9	41.2	11.2	8.0	13.4	13.3	12.0	13.4	-$9,004	-$5,360	-6.9	-2.0	-6.9	-1.0
2017	9.0	13.2	26.5	20.6	39.7	33.8	6.1	1.8	9.5	7.9	12.4	13.1	-$9,638	-$5,485	-5.9	-0.1	-5.9	0.9
2018	9.0	13.2	27.9	21.3	41.1	34.5	14.7	12.6	10.2	9.7	13.9	15.3	-$10,928	-$5,663	-6.0	0.5	-6.0	1.6
2019	9.0	13.2	33.6	28.8	46.8	42.0	14.9	14.3	12.0	12.6	13.0	14.2	-$14,834	-$8,410	-8.7	-2.7	-8.7	-1.7
2020	9.0	13.2	33.0	28.2	46.2	41.4	11.2	8.5	12.8	13.8	12.9	13.5	-$18,059	-$10,689	-10.2	-4.7	-10.2	-3.6
2021	9.0	13.2	32.5	25.7	45.7	38.9	11.8	8.6	12.4	12.9	14.1	15.3	-$20,458	-$11,290	-10.5	-4.3	-10.4	-3.1
2022	9.0	13.2	37.1	30.8	50.3	44.0	15.0	13.8	13.5	14.5	13.8	15.4	-$26,498	-$14,776	-12.7	-6.6	-12.7	-5.4
2023	9.0	13.2	37.9	32.4	51.1	45.7	10.8	8.8	13.4	14.6	12.9	13.8	-$33,601	-$19,795	-15.1	-9.8	-15.1	-8.6
2024	9.0	13.2	35.9	28.8	49.1	42.0	10.2	6.9	13.5	14.8	13.5	14.5	-$38,983	-$22,510	-16.0	-10.6	-16.0	-9.4
2025	9.0	13.2	37.8	30.5	51.0	43.7	12.6	10.6	13.6	15.2	13.8	15.1	-$47,522	-$27,235	-17.5	-12.2	-17.5	-11.0
Aver-age	9.0	13.2	32.4	27.1	45.6	40.3	12.1	9.8	12.9	13.1	13.4	15.2	-$19,949	-$11,125	-9.6	-3.6	-9.6	-3.0

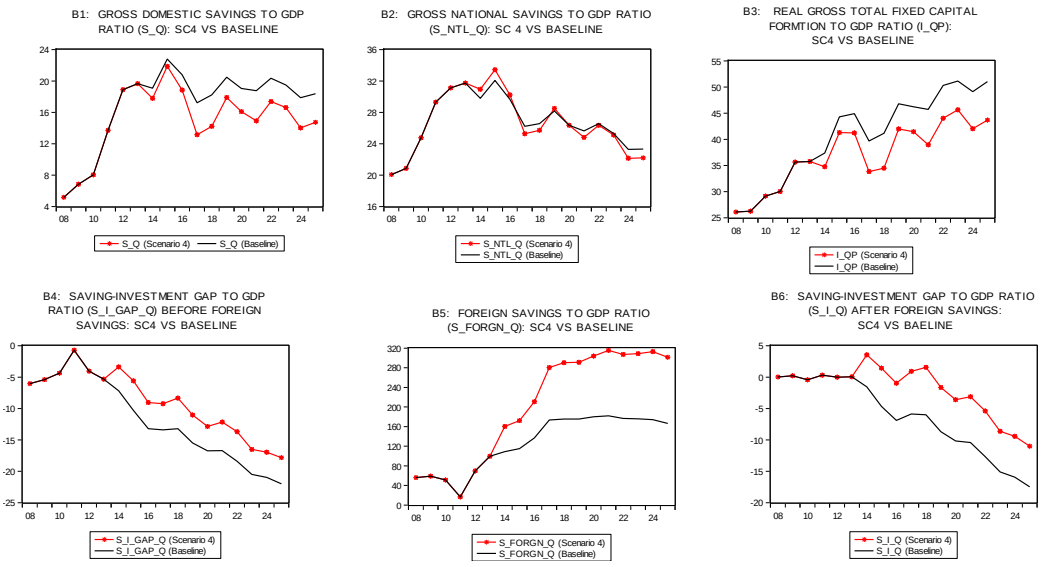
1/ Figures for fiscal year 2013 are actuals.

Figures 3-28: Effects of Lowering Potential Growth Assumption to 9 percent and Devaluation of the Birr by 20 Percent Simultaneously.

A. Goods and Services and Money Market

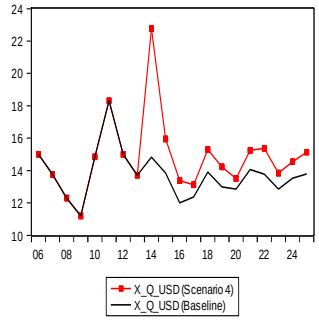


B. Saving and Investment

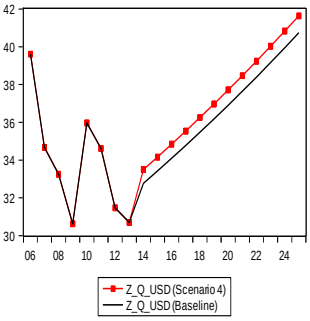


C. External Sector

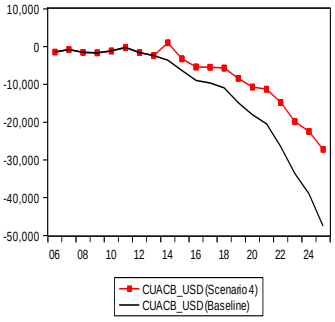
C1 EXPORTS OF G&S TO GDP RATIO (X_Q_USD): SC 4 VS BASELINE



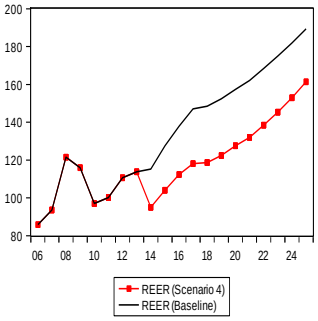
C2 IMPORTS OF G&S TO GDP RATIO (Z_Q_USD): SC 4 VS BASELINE



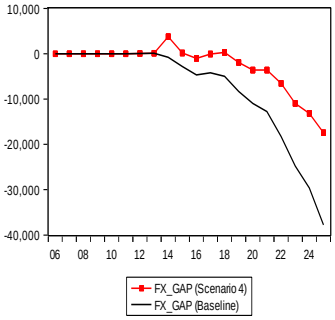
C3 CURRENT ACCOUNT BALANCE IN USD (CUACB_USD): SC 4 VS BASELINE



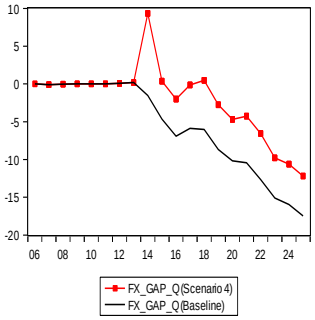
C4 REAL EFFECTIVE EXCHANGE RATE (REER): SC 4 VS BASELINE



C5 FOREIGN EXCHANG GAP IN USD (FX_GAP): SC 4 VS BASELINE

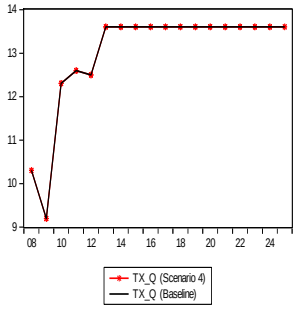


C6 FOREIGN EXCHANGE GAP TO GDP RATIO (FX_GAP_Q): SC 4 VS BASELINE

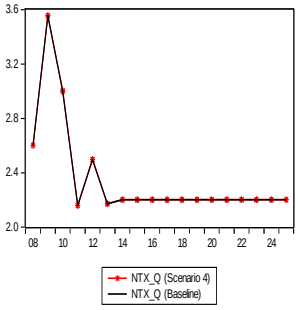


D. Government Sector

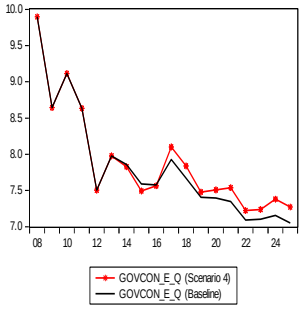
D1: TOTAL TAX REVENUE TO GDP RATIO (TX_Q): SC4 VS BASELINE



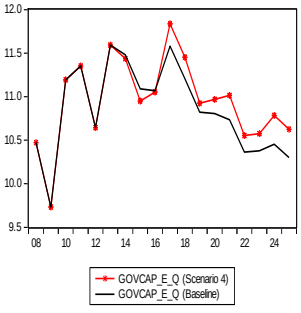
D2: NON-TAX REVENUE TO GDP RATIO (NTX_Q): SC4 VS BASELINE



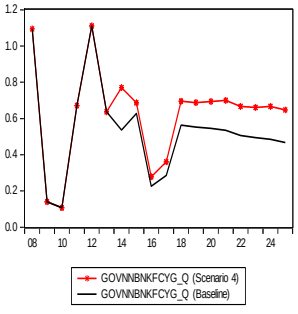
D3: GOVERNMENT CONSUMPTION EXPENDITURE TO GDP RATIO (GOVCON_E_Q): SC4 VS BASELINE



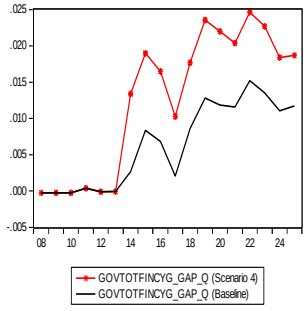
D4: GOVERNMENT CAPITAL EXPENDITURE TO GDP RATIO (GOVCAP_E_Q): SC4 VS BASELINE



D5: NON-BANK FINANCING TO GDP RATIO (GOVNNBNKFCYG_Q): SC4 VS BASELINE



D6: TOTAL GOVERNMENT FINANCING GAP TO GDP RATIO (GOVTOTFINCYG_GAP_Q): SC4 VS BASELINE



coordinating exchange rate policy with aggregate demand policy produces better results in terms of sustaining growth and redressing current account deficit and saving-investment gap [Mbaye, 2012 and Skott et al, 2012].

Scenario V. Central Bank Decision to Reduce Base Money by 7 percent selling 30 percent of its Financial Asset Holdings through Open Market Operation.

These results are presented in Table 3-22 and Figures 3-29. The objective of simulation is to experiment with the effect of a monetary policy shock in addressing money market disequilibrium. By selling the stock of bonds in its possession, the central bank immediately withdraws an equivalent amount of currency stock from circulation. Consequently, excess money supply shrinks in the first four years until 2017 (Figure 3.29(A7)) and it is back to its long run trend[93]. This results in slightly lower inflation (Table 3.22 and Figure 3-29(A8)) which in turn helps the real exchange rate depreciate (Figure 3-29(C4)). (Recall that the nominal exchange rate is assumed fixed because it is a policy variable.) With a lower real exchange rate, exports increase while, as we have seen above, imports more or less maintain their baseline levels, so that the current account improves (Table 3.22 and Figure 3.29(C3)). And, following this, the savings and investment gap improves slightly.

As we can see from Figure 3-29(A1), the real GDP graph, there is no observable effect on output from this deflationary impulse; this is because REER depreciates slightly which is expected to the real sector through exports, as inflation drops marginally. The lower inflation also weakens the transmission to the real sector through the real interest rate which is expected to lower private consumption demand. Moreover, since the improvements in the financing gaps are so small, cutting the money supply does not serve to improve materially the chances of achieving the GTP targets.

In the government sector, the contractionary policy reduces the demand for government securities by the non-bank public in the first four years (Figure D5) which in turn is

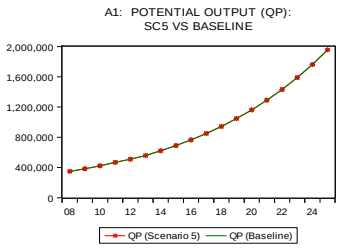
[93] The policy is a onetime shock in reserve money stock but it has a permanent effect on the level of reserve money.

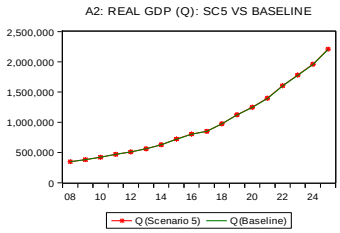
Table 3-22: Simulation Forecast Results Assuming Lower Reserve Money Growth

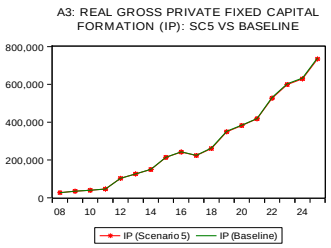
	Long-term Output Growth Target (gT)	Investment Requirement					Short-Run Aggregate Supply Growth (Q%)		Inflation		External Sector							
		Public Investment Requirement (IG_Q)	Private Sector Investment Requirement (% GDP) (IP_Q)		Total Investment Requirement (% GDP) (I_Q)						Export of G&S (% GDP) (X_USD_Q)		Current Account Balance (in Millions of USD) (CUACB_USD)		Foreign Exchange Gap (% GDP) (FX_GAP_Q)		Saving-Investment Gap (S_I_Q)	
	Target	Policy	Bs	Sc.5	Bs	Sc.5	Bs	Sc.5	Bs	Sc.5	Bs	Sc.5	Bs	Sc.5	Bs	Sc.5	Bs	Sc.5
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2013	11.0	13.2	22.6	22.6	35.8	35.8	9.7	9.7	12.3	12.3	13.7	13.7	-$2,346.00	-$2,346.00	0.2	0.2	0.0	0.0
2014	11.0	13.2	24.2	24.1	37.4	37.3	12.0	12.1	13.3	11.1	14.8	15.0	-$3,573.00	-$3,415.00	-1.6	-1.3	-1.6	-1.2
2015	11.0	13.2	31.1	31.0	44.3	44.2	14.9	15.1	16.8	14.4	13.8	14.2	-$6,294.00	-$5,830.00	-4.7	-4.0	-4.7	-4.0
2016	11.0	13.2	31.7	31.6	44.9	44.8	11.2	11.2	13.4	12.4	12.0	12.4	-$9,004.00	-$8,352.00	-6.9	-6.1	-6.9	-6.1
2017	11.0	13.2	26.5	26.3	39.7	39.5	6.1	6.0	9.5	9.4	12.4	12.7	-$9,638.00	-$8,938.00	-5.9	-5.1	-5.9	-5.1
2018	11.0	13.2	27.9	27.6	41.1	40.8	14.7	14.7	10.2	10.1	13.9	14.2	-$10,928.00	-$10,131.00	-6.0	-5.2	-6.0	-5.2
2019	11.0	13.2	33.6	33.3	46.8	46.5	14.9	15.0	12.0	12.1	13.0	13.3	-$14,834.00	-$13,915.00	-8.7	-8.0	-8.7	-8.0
2020	11.0	13.2	33.0	32.9	46.2	46.1	11.2	11.3	12.8	13.1	12.9	13.2	-$18,059.00	-$17,104.00	-10.2	-9.5	-10.2	-9.5
2021	11.0	13.2	32.5	32.4	45.7	45.6	11.8	11.8	12.4	12.8	14.1	14.4	-$20,458.00	-$19,433.00	-10.5	-9.8	-10.4	-9.8
2022	11.0	13.2	37.1	36.8	50.3	50.0	15.0	14.9	13.5	13.8	13.8	14.2	-$26,498.00	-$25,270.00	-12.7	-12.0	-12.7	-12.0
2023	11.0	13.2	37.9	37.7	51.1	50.9	10.8	10.8	13.4	13.6	12.9	13.3	-$33,601.00	-$32,240.00	-15.1	-14.5	-15.1	-14.5
2024	11.0	13.2	35.9	35.7	49.1	48.9	10.2	10.2	13.5	13.7	13.5	14.0	-$38,983.00	-$37,544.00	-16.0	-15.4	-16.0	-15.4
2025	11.0	13.2	37.8	37.5	51.0	50.7	12.6	12.6	13.6	13.9	13.8	14.2	-$47,522.00	-$45,967.00	-17.5	-16.9	-17.5	-16.9
Aver-age	11.0	13.2	32.4	32.2	45.6	45.4	12.1	12.1	12.9	12.5	13.4	13.8	-$19,949.33	-$19,011.58	-9.6	-9.0	-9.6	-9.0

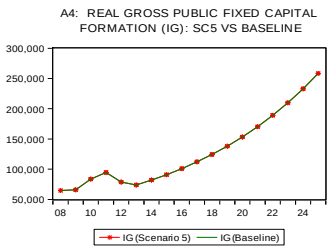
Figures 3-29: Effects of Central Bank Decision to Reduce Base Money

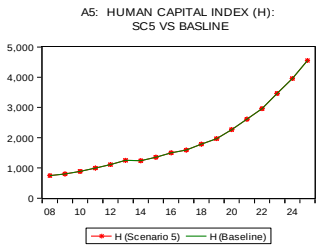
A. Goods and Services and Money Market

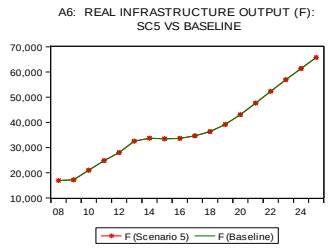


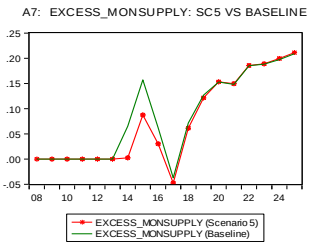


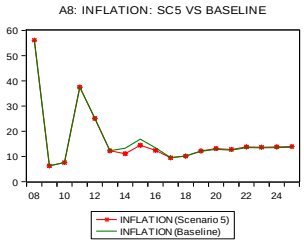


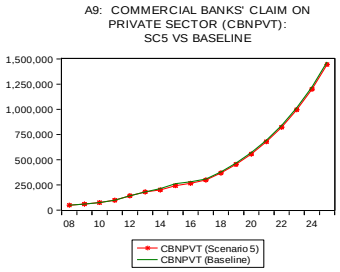












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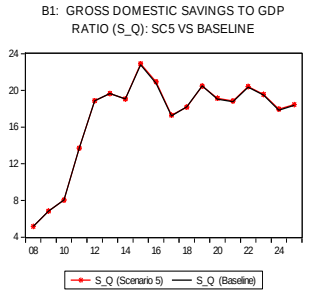
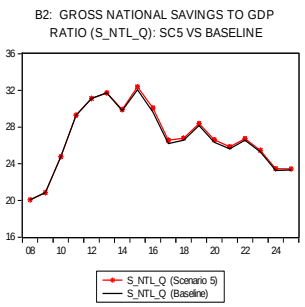
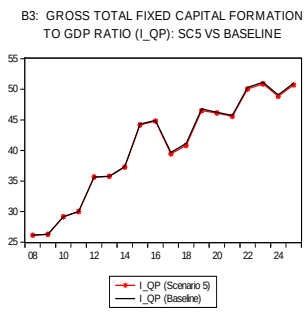
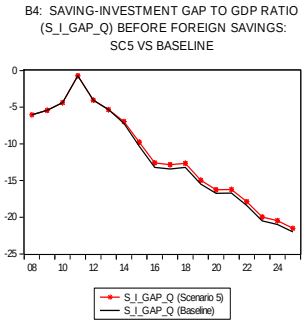
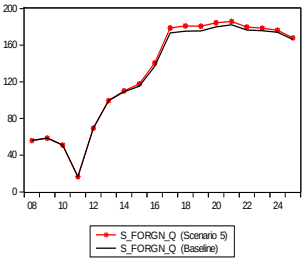
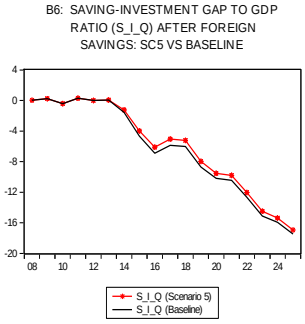




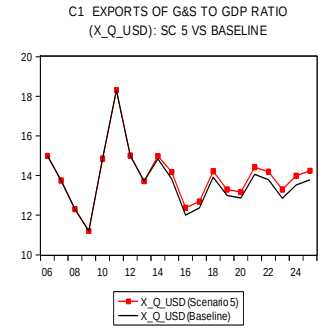


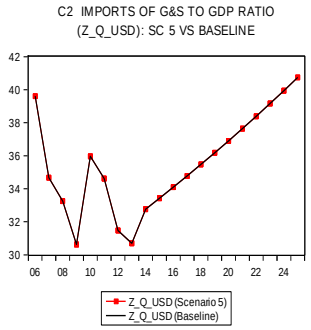


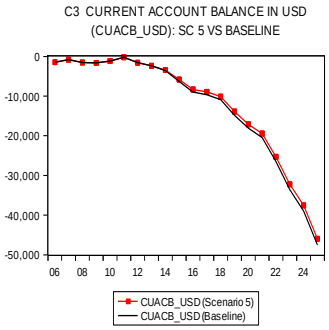


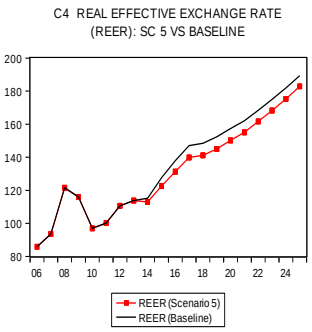


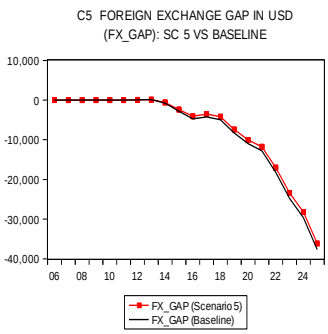
C. External Sector

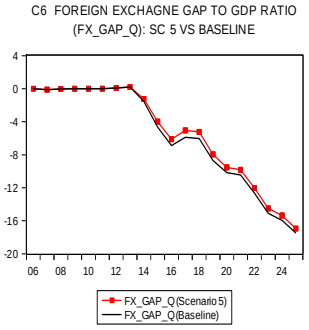




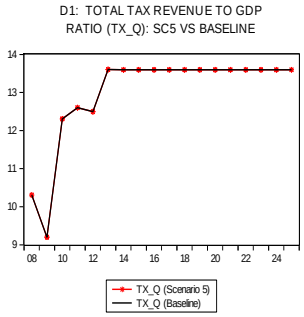


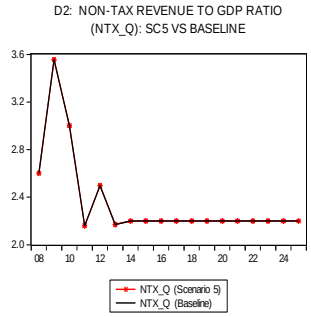


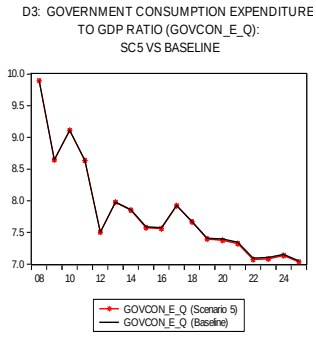


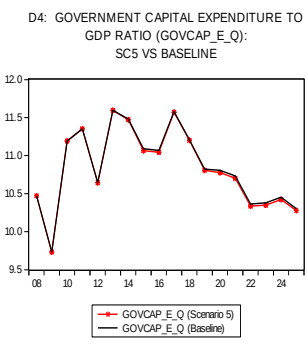


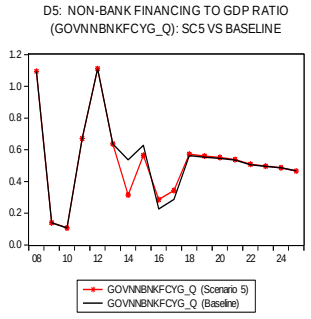
D. Government Sector

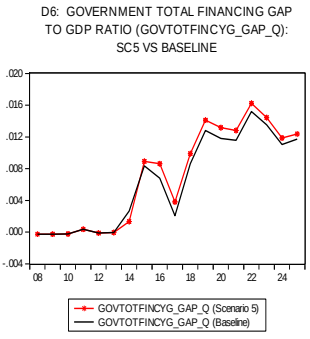












reflected in a moderate decline in the government financing surplus in 2014 and 2015 (Figure 3-29(D6)). However, the surplus increases since 2016 due to a slightly lower

capital expenditure as percentage of GDP (Figure 3-29(D4)) and an increase in the non-bank public demand for government securities.

Scenario VI. Solving for Exchange Rate Policy that Bring Foreign Exchange Gap (FX-Gap) to zero

In the first five scenarios, I have tried to demonstrate the reactions of the various markets for alternative policy shocks. In this scenario, the model is asked to solve for the desired equilibrium level of exchange rate that brings the foreign exchange gap to zero so that the government's growth targets will be realized and thus the position will be sustainable. As demonstrated in scenarios 1 and 4, exchange rate policy is the primary policy instrument to address external and internal imbalance in the Ethiopian model. Therefore, using E-views' 'Solve Control for Target' window, the model is requested to solve for the equilibrium exchange rate path. The simulation results are presented in column 3 of Table 3.23.

It is clear from Table 3.23 that, to bring the foreign exchange gap to zero, the pace of devaluation need to be slower in the first five years than the case under scenario 1 (Table 3.21, column 2) and needs to be faster afterwards. By 2025, the value of the Birr needs to go as low as 78 Birr per dollar compared with 58 Birr per dollar under scenario 1, the 40 percent depreciation scenario. Table 3.18 proves that the 40 percent devaluation produces a foreign exchange surplus as high as 13 percent in the first year, 2014, and stays in surplus for the next four years until 2018. On the contrary, after 2018, it turns into a continuously widening deficit. So, one of the messages of the exercise is that exchange rate adjustment must not be a one-time act rather it must me a carefully monitored but continuous adjustment to keep the real exchange rate competitive [Rapetti, 2011and Aguirre and Calderon, 2005]. One issue with this policy conclusion is to ask whether a steady and anticipated depreciation will have the same effects as the essentially unforeseen surprise devaluation that the financial programming model presumes. The risk with the former is that the goods and money markets may take into account anticipated depreciation in their respective equilibrium processes, and make the policy ineffective.

Table 3-23: Exchange Rate Simulation Results for Zero Foreign Exchange Gap

	Exchange Rate of the Birr (E)		
	Baseline Scenario[1/]	40 Percent Devaluation (Scenario 1)	Simulation Result for the FX_GAP_TAGET (Scenario 6)
	(1)	(2)	(3)
2014	19.3	27.0	20.6
2015	20.4	28.6	24.7
2016	21.7	30.4	28.7
2017	23.0	32.2	28.9
2018	24.4	34.1	31.1
2019	25.8	36.2	36.4
2020	27.4	38.3	40.6
2021	29.0	40.6	44.3
2022	30.8	43.1	51.6
2023	32.6	45.7	59.0
2024	34.6	48.4	66.0
2025	36.6	51.3	78.4

1/6% annual deprecation of the Birr is already assumed in the baseline scenario

In the goods market, annual average growth in aggregate supply actual increases from 12.1 percent in the baseline to 12.9 percent (Table 3.24). This results from a sharp increase in exports from 13.4 percent in the baseline to 17.2 percent of GDP. The boost in exports generates higher spillover effect to output. Consequently, despite a strong increase in aggregate supply compared with the baseline, the required level of total investment declines by 2 percentage points from 45.6 percent to 43.6 percent of GDP on average (Table 3.24, column 6). Table 3.24 and Figures 3-30(B6) and (C6) also show that this scenario produces not only zero foreign exchange gaps, which the model solves for, but also a zero saving-investment gap. In the government sector, lower capital and consumption expenditure as ratios of GDP and higher demand for government securities by the non-bank sector due to improved income from exports result in a large surplus in government financing.

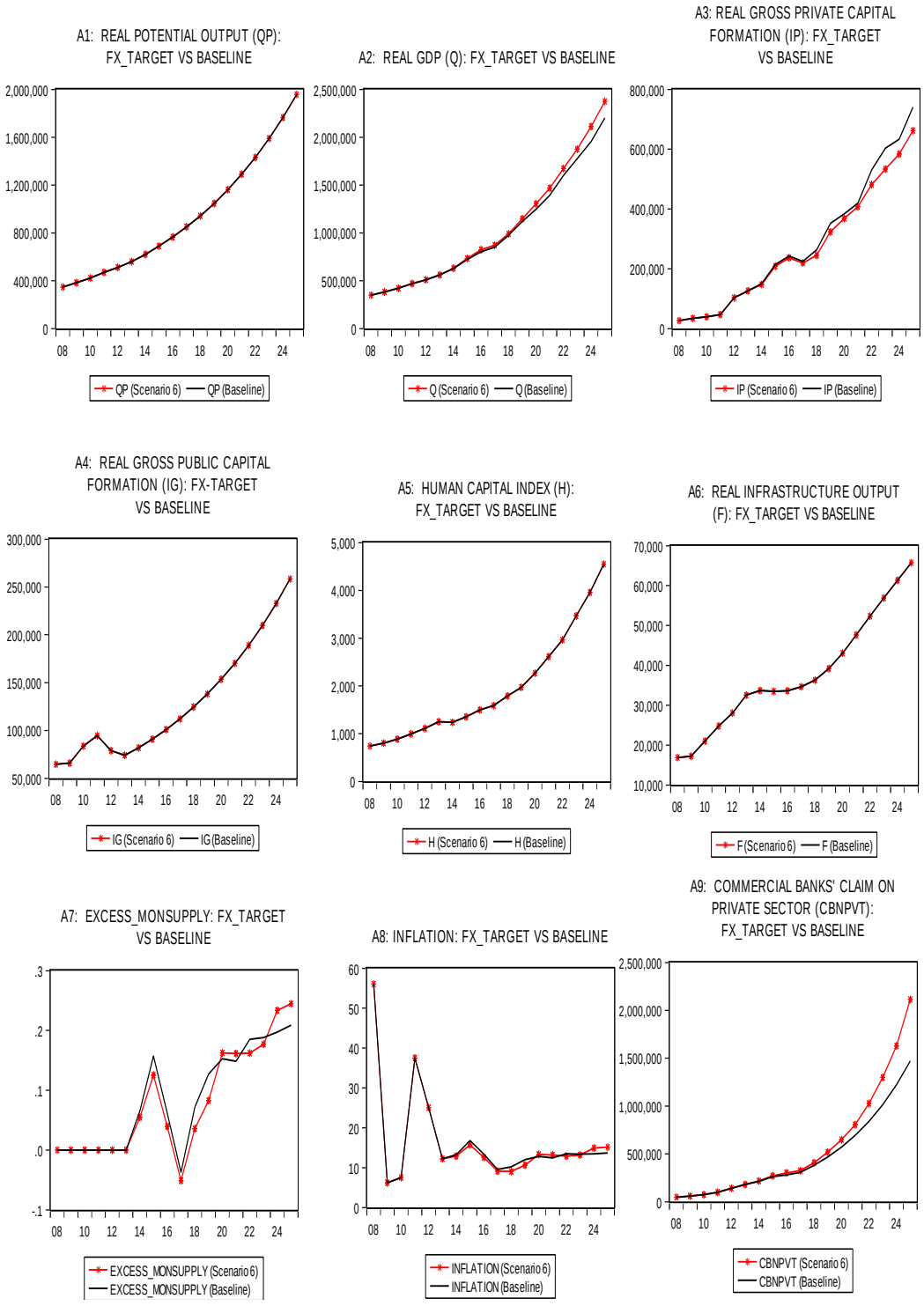
Table 3-24: Forecast Simulation Results by Forcing the Model to Solve for the Exchange Rate Path

	Long-term Output Growth Target (gT)	Investment Requirement					Short-Run Aggregate Supply Growth (Q%)		Inflation		External Sector						Saving-Investment Gap (S_I_Q)	
		Public Investment Requir-ement (IG_Q)	Private Sector Investment Requirement (% GDP) (IP_Q)		Total Investment Requirement (% GDP) (I_Q)						Export of G&S (% GDP) (X_USD_Q)		Current Account Balance (in Millions of USD) (CUACB_USD)		Foreign Exchange Gap (% GDP) (FX_GAP_Q)			
	Target	Policy	Bs	Sc.6	Bs	Sc.6	Bs	Sc.6	Bs	Sc.6	Bs	Sc.6	Bs	Sc.6	Bs	Sc.6	Bs	Sc.6
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2013	11.0	13.2	22.6	22.6	35.8	35.8	9.7	9.7	12.3	12.3	13.7	13.7	-$2,346	-$2,346	0.2	0.3	0.0	0.0
2014	11.0	13.2	24.2	23.8	37.4	37.0	12.0	12.5	13.3	12.9	14.8	15.3	-$3,573	-$2,802	-1.6	0.0	-1.6	0.0
2015	11.0	13.2	31.1	30.3	44.3	43.5	14.9	16.4	16.8	15.7	13.8	15.5	-$6,294	-$3,451	-4.7	0.0	-4.7	0.0
2016	11.0	13.2	31.7	30.8	44.9	44.0	11.2	12.5	13.4	12.6	12.0	14.4	-$9,004	-$4,298	-6.9	0.0	-6.9	0.0
2017	11.0	13.2	26.5	25.8	39.7	39.0	6.1	5.8	9.5	9.1	12.4	14.3	-$9,638	-$5,415	-5.9	0.0	-5.9	0.0
2018	11.0	13.2	27.9	26.1	41.1	39.3	14.7	13.5	10.2	9.0	13.9	15.5	-$10,928	-$5,948	-6.0	0.0	-6.0	0.0
2019	11.0	13.2	33.6	30.9	46.8	44.1	14.9	15.7	12.0	10.6	13.0	15.6	-$14,834	-$6,507	-8.7	0.0	-8.7	0.0
2020	11.0	13.2	33.0	31.7	46.2	44.9	11.2	13.8	12.8	13.3	12.9	16.7	-$18,059	-$7,085	-10.2	0.0	-10.2	0.0
2021	11.0	13.2	32.5	31.6	45.7	44.8	11.8	12.5	12.4	13.2	14.1	18.2	-$20,458	-$7,675	-10.5	0.0	-10.4	0.0
2022	11.0	13.2	37.1	33.6	50.3	46.8	15.0	14.1	13.5	12.9	13.8	18.8	-$26,498	-$8,263	-12.7	0.0	-12.7	0.0
2023	11.0	13.2	37.9	33.6	51.1	46.8	10.8	12.1	13.4	13.2	12.9	19.6	-$33,601	-$8,831	-15.1	0.0	-15.1	0.0
2024	11.0	13.2	35.9	33.1	49.1	46.3	10.2	12.5	13.5	14.9	13.5	21.2	-$38,983	-$9,352	-16.0	0.0	-16.0	0.0
2025	11.0	13.2	37.8	33.8	51.0	47.0	12.6	12.5	13.6	15.1	13.8	21.8	-$47,522	-$9,792	-17.5	0.0	-17.5	0.0
Aver-age	11.0	13.2	32.4	30.4	45.6	43.6	12.1	12.8	12.9	12.7	13.4	17.2	-$19,949	-$6,618	-9.6	0.0	-9.6	0.0

1/ Figures for fiscal year 2013 are actuals

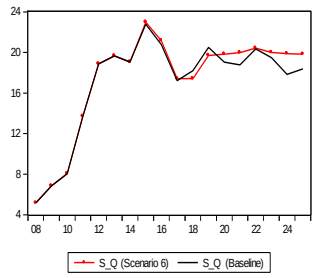
Figures 3-30: Solving for Exchange Rate Policy that Bring Foreign Exchange Gap (FX-Gap) to zero

A. Goods and Services and Money Market

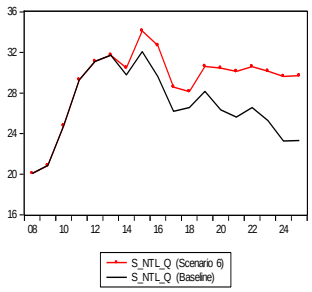


B. Saving and Investment

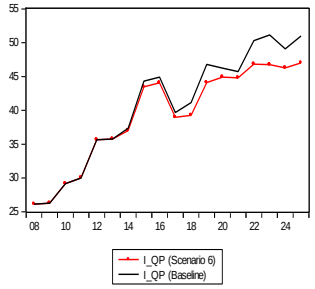
B1: DOMESTIC SAVINGS TO GDP RATIO (S_Q): FX_TARGETVS BASELINE



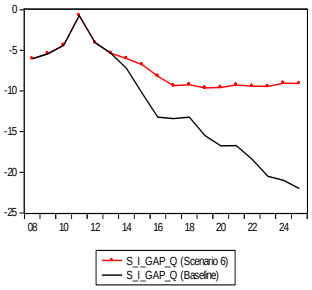
B2: NATIONAL SAVINGS TO GDP RATIO (S_NTL_Q): FX_TARGET VS GDP



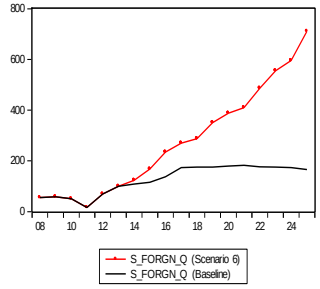
B3: GROSS TOTAL FIXED CAPITAL FORMATION TO GDP RATIO (I_QP): FX_TARGET VS BASELINE



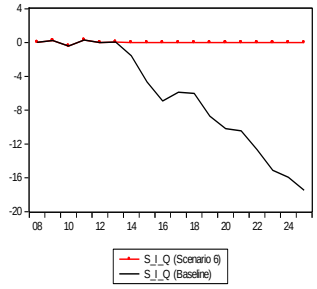
B4: SAVING-INVESTMENT GAP TO GDP RATIO BEFORE FOREIGN SAVINGS (S_I_GAP_Q): FX_TARGET VS BASELINE



B5: FOREIGN SAVINGS TO GDP RATIO (S_FORGN_Q): FX-TARGET VS BASELINE

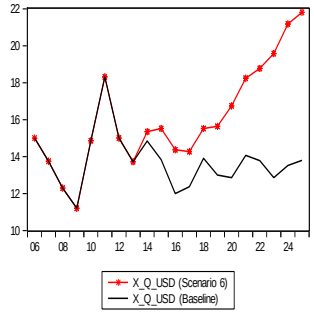


B6: SAVING-INVESTMENT GAP TO GDP RATIO AFTER FOREIGN SAVNGS (S_I_Q): FX_TARGET VS BASELINE

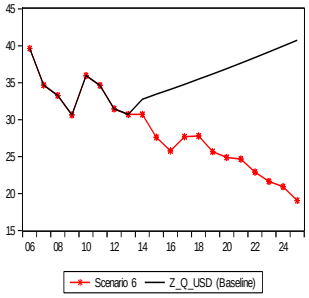


C. External Sector

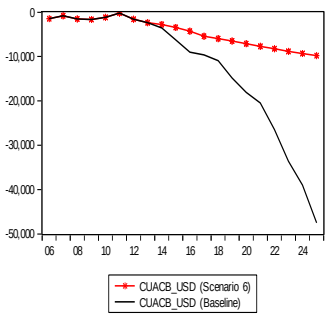
C1 EXPORTS OF G&S TO GDP RATIO (X_Q_USD): SC 6 VS BASELINE



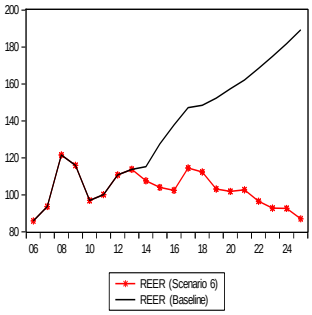
C2 IMPORTS OF G&S TO GDP RATIO (Z_Q_USD): SC 6 VS BASELINE



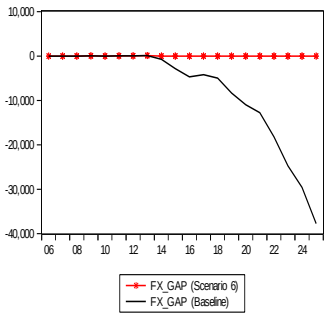
C3 CURRENT ACCOUNT BALANCE IN USD (CUACB_USD) SC 6 VS BASELINE



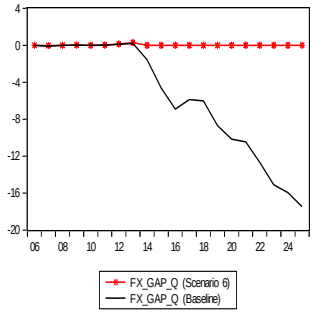
C4 REAL EFFECTIVE EXCHANGE RATE INDEX (REER): SC 6 VS BASELINE



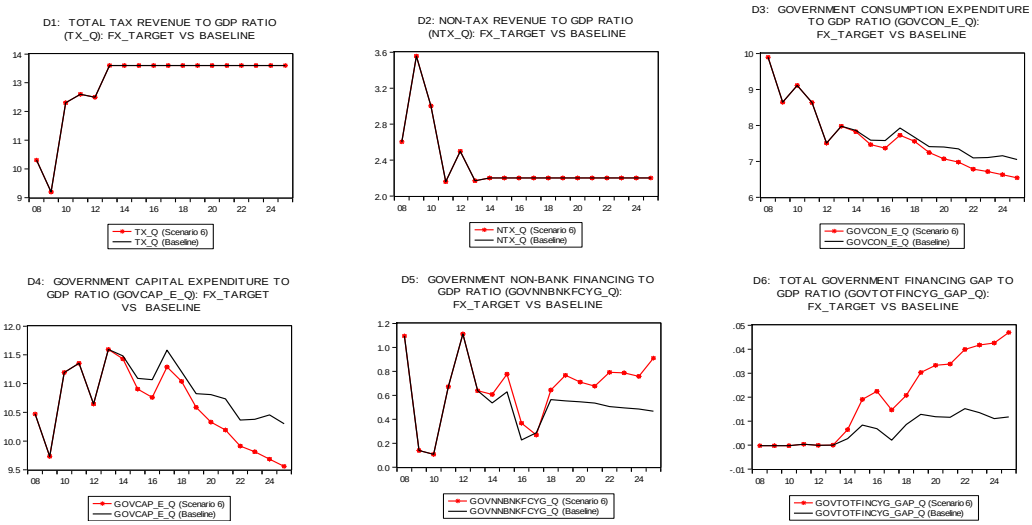
C5 FOREIGN EXCHANGE GAP IN USED (FX_GAP): SC 6 VS BASELINE



C6 FOREIGN EXCHANGE GAP TO GDP RATIO (FX_GAP_Q): SC 6 VS BASELINE



D. Government Sector



3.9 Conclusion

In this chapter, we have seen that, similar to the East Asian tigers between the1960s and 1990s, Ethiopia has experienced a sustainably high growth scenario. Economic growth accelerated from an annual average of 4.5 percent between 1993 and 2002 to 10.9 percent during the last 10 years (2004-2013). We also observe that the growth was heavily investment driven and that there was a moderate contribution from an increase in total factor productivity, particularly through the spillover effects of growth in infrastructure services, human capital and exports. The long-run growth model reveals that 85.7 percent of the growth comes from physical capital accumulation and only 12.4 percent comes from a rise in total factor productivity. Of the latter, human capital development, infrastructure output growth and export growth contributed 3.7 percent, 3.0 percent and 1.9 percent respectively, and the remaining 3.9 percent comes from residual TFP. As a typical labor surplus economy, the contribution of labor is found to be only 1.9 percent. This makes Ethiopia's growth experience different from its East Asian counterpart – China. In China, the physical capital stock, labor and human capital stock contributed 47.7 percent, 15.9 percent and 11.0 percent respectively, during the reform period (1978-1999), while the

remaining 25.4 percent is found to be explained by the residual TFP [Wang and Yao, 2002].

The First Five-year Growth and Transformation (2011-2015) announces an annual average growth target of 11.2 percent and the vision statement indicates that the government will continue to target double digit growth in the Second and the Third Five-year Growth and Transformation Plans, in order to join the club of lower middle income countries by 2025. However, the baseline simulation exercise warns that the current over reliance of growth on physical capital accumulation raises the question of viability of the plans in the coming years. The simulation shows that as the Ethiopian economy grows in size, the required amount of investment as a percentage of GDP increases dramatically.

Assessment of the consistency of GTP-I, using the modified financial programming (MFP), found that, first, the plan under predicted the required level of investment to maintain the targeted level of growth in the absence of clear knowledge about the contribution of total factor productivity. The plan envisaged raising the total investment to GDP ratio from 22.3 percent in 2010 to 28.1 percent by 2013. However, the simulation exercise, assuming the same sets of policies as the plan, found that in order to maintain the average 11.2 percent growth rate over the five-year plan period, gross total fixed investment would have to increase to 36.9 percent by 2013. The latter is close to the actual investment ratio (38.4 percent) required in 2013.

Second, the lack of an explicit exchange rate policy to keep the export market competitive is also found to be inconsistent with both the planned real GDP growth and export projections. The appreciation of the exchange rate by 14% between 2011 and 2013 depressed exports growth and contributed a fair share of the deviation between the actual and projected growth rates in two ways. First, as a component of the demand side of the GDP, lower growth in exports means a lower contribution to growth. Second, the export spillover effect on TFP would also be lower.

The third inconsistency is the plan's under-predication of the domestic resource required to finance the intended investment. The plan aims to raise the domestic savings-to-GDP ratio to 12.4 percent by 2013. However, the simulation result indicates that, assuming a

zero saving-investment gap, domestic savings must increase to 18.6 percent of GDP by 2013. Otherwise, growth would have been much lower than achieved in 2013 because of financing constraint.

The baseline forecasts for the next 12 years (2014-2025) also reveal major inconsistencies between policies and targets. Simulation results of the baseline scenario assuming an annual average 11 percent growth and a 9 percent inflation target, forecasts ever-widening current account deficits and foreign exchange gaps. For instance, the annual current account deficit is forecast to reach USD 47.5 billion by 2025 from USD 2.3 billion in 2013. Consequently, the foreign exchange and saving-investment gaps are forecast to reach 17.5 percent of GDP each, by 2025. This implies that, under the baseline scenario, the 11 percent growth target is not feasible. So, the government needs to reconsider its growth targets or must consider major policy adjustments to bring the gaps to zero.

Six alternative policy scenarios were run above to see the responses of the various markets and to test how the policy shocks address the resource gaps. The model responds very positively to an exchange rate shock. A 40 percent one-time devaluation increases exports to 18.4 percent of GDP from 13.8 percent in the baseline. Consequently, the average annual current account deficit shrinks to USD 9.8 billion from USD 19.9 billion and the foreign exchange gap turns to a surplus for the first four years during 2014-2017. The saving-investment gap also sees a significant reduction, from 9.6 percent of GDP in the baseline to 6.1 percent. The spillover effect from the strong export growth also lowers the required amount of total investment from 45.6 percent to 43.3 percent of GDP, despite the increase in the annual average aggregate supply growth rate to 12.3 percent from 12.1 percent, in the baseline. This implies that the exchange rate is an effective policy instrument in addressing problems related to the resource gap.

The second policy scenario, which aims at increasing private savings through forced savings scheme, on the other hand, seems to be less effective, although it produces the expected results in terms of the reaction of the various markets. Despite the assumption to lower the magnitude of the income elasticity of consumption by 4 percentage points, the average annual saving-investment gap is lowered only by 0.2 percentage points from -9.6

percent in the baseline to -9.4 percent. On the contrary, aggregate supply growth responds relatively strongly due to the direct effect of reduced aggregate consumption on aggregate demand. The latter comes down to 11.8 percent from 12.1 percent in the baseline. Consequently, despite a marginal improvement in the current account balance mainly due to a reduction imports, the effect on export growth is also slightly negative.

The third scenario which assumes a 2 percentage point lower potential GDP growth rate than the baseline also produced mixed results, although the responses in terms of the narrowing of the foreign exchange and saving-investment gaps are positive. Exports see slight declines from the baseline while average inflation rises marginally to 13.2 percent from 12.9 percent in the baseline. Lower aggregate supply growth is the main reason behind the depressed export growth and rising inflation. On the other hand, the current account deficit narrows down from USD19.9 billion in the baseline to USD15.8 billion mainly due to decline in imports.

The simulation, which runs a lower potential growth assumption (scenario 3) combined with a 20 percent devaluation of the Birr, gets positive responses in almost all markets considered except in the money market. Notwithstanding a 2-percentage point reduction in potential GDP growth, the 20 percent devaluation boosts exports to 15.2 percent of GDP from 13.4 percent in the baseline. Consequently, the average annual current account deficit goes down to USD 11.1 billion from USD19.9 billion. The saving-investment gap experiences a significant improvement, narrowing to 3 percent of GDP. Therefore, the lesson this exercise is that use of combined policies produces better results than taking one policy measure at a time.

The contractionary monetary policy scenario that aims at addressing the money market disequilibrium by reducing the base money, also produced the expected results. Inflation goes down, resulting in a real deprecation of the exchange rate. The latter, in turn, boosts export growth and narrows down the gaps in foreign exchange market and saving and investment. This indicates that, during high aggregate demand pressure, monetary policy could be invoked as an effective instrument to address excess demand.

Last but not the least is the lesson from the sixth scenario, which solves for the equilibrium exchange rate. The simulation that targets a zero foreign exchange gap throughout the projection period has demonstrated that exchange rate is an effective policy instrument in addressing the resource gap problem. It illustrates that exchange rate adjustment needs not to be a one-time big shock, but instead must be a carefully designed series of depreciations that takes into account projected resource gaps in individual years. One issue with this policy conclusion is to ask whether a steady and anticipated depreciation will have the same effects as the essentially unforeseen surprise devaluation that the financial programming model presumes.

To conclude, this chapter finds that the targets in the Growth and Transformation Plans could be achieved only if the inconsistencies observed in the baseline scenario between the targets and the policy mixes and, the consequent widening resources gaps are properly addressed. This demands the government to reexamine its current policy mixes.

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Appendices

Appendix for Chapter 1

Annex 1.1 Derivation of the Three-Sector Model with Expected Infrastructure Output Growth

$$\begin{cases} F = F(L_F, K_F, G_F) \\ X = X(L_X, K_X ; F^*) \\ R = R(L_R, K_{R,}; F^*, X) \\ Y = F + R + X \end{cases} \quad \text{..... 1}$$

Assumptions:

Assmption1. Factor productivity difference between the export sector and private sector output, and generates spill-over to non-export private sector through skilled labour and high managerial efficiency.

$$\begin{cases} \underline{MPPL_F}/MPPL_R = \underline{MPPK_F}/MPPK_R = 1, \\ \underline{MPPL_X}/MPPL_R = \underline{MPPK_X}/MPPK_R = 1 + \delta \end{cases} \quad \text{..... 2}$$

$$-\infty < \delta < \infty$$

Assumption 2: Public infrastructure output generates externalities to the rest of the economy, and expected growth in infrastructural output attracts more investment in the rest of the economy.

$$F^*_t - F^*_{t-1} = \theta\,[F_{t-1} - F^*_{t-1}], \quad 0 < \theta \leq 1 \quad \text{..... 3}$$

$$\begin{cases} dF = \partial F/\partial K_F\,(dK_F) + \partial F/\partial L_F\,(dL_F) + \partial F/\partial G_F\,(dG_F) \\ dX = \partial X/\partial K_X\,(dK_X) + \partial X/\partial L_X\,(dL_X) + \partial X/\partial F\,(dF^*) \\ dR = \partial R/\partial K_R\,(dK_R) + \partial R/\partial L_R\,(dL_R) + \partial R/\partial F\,(dF^*) + \partial R/\partial X\,(dX) \end{cases} \quad \text{..... 4}$$

Using equation 5, we can substitute $(1+\delta)\ \partial R/\partial K_R$ to $\partial X/\partial K_X$ and $\partial R/\partial K_R$ to = $\partial F/\partial K_F$; and the same applies to labour inputs.

$$\begin{cases} dF = \partial R/\partial K_R\,(dK_F) + \partial R/\partial L_R\,(dL_F) + \partial F/\partial G_F\,(dG_F) \\ dX = (1+\delta)\,\partial R/\partial K_R\,(dK_X) + (1+\delta)\,\partial R/\partial L_R\,(dL_X) + \partial X/\partial F\,(dF^*) \\ dR = \partial R/\partial K_R\,(dK_R) + \partial R/\partial L_R\,(dL_R) + \partial R/\partial F\,(dF^*) + \partial R/\partial X\,(dX) \end{cases} \quad \ldots\ldots 5$$

$$\begin{cases} dF = \partial R/\partial K_F\,(dK_F) + \partial R/\partial L_R\,(dL_F) + \partial F/\partial G_F\,(dG_F) \\ 1/(1+\delta)\,dX = \partial R/\partial K_R\,(dK_X) + \partial R/\partial L_R\,(dL_X) + [1/(1+\delta)]\partial X/\partial F\,(dF) \\ dR = \partial R/\partial K_R\,(dK_R) + \partial R/\partial L_R\,(dL_R) + \partial R/\partial F\,(dF) + \partial R/\partial X\,(dX) \end{cases} \quad \ldots\ldots 6$$

$$dF+dR+1/(1+\delta)\,dX = \partial R/\partial K_R[DK_F + dK_R + dK_X] + \partial R/\partial L_R[dL_F + dL_R + dL_X] + \partial F/\partial G_F(dG_F) + [1/(1+\delta)]\partial X/\partial F(dF) + \partial R/\partial F(dF) + \partial R/\partial X(dX) \quad \ldots\ldots 7$$

$$dY + 1/(1+\delta)\,dX - dX = \partial R/\partial K_R(dK) + \partial R/\partial L_R(dL) + \partial F/\partial G_F(dG_F) + [1/(1+\delta)]\partial X/\partial F^*(dF^*) + \partial R/\partial F^*(dF^*) + \partial R/\partial X(dX) \quad \ldots\ldots 8$$

$$dY - \delta/(1+\delta)\,dX = \partial R/\partial K_R(dK) + \partial R/\partial L_R(dL) + \partial F/\partial G_F(dG_F) + [1/(1+\delta)]\partial X/\partial F^*(dF^*) + \partial R/\partial F^*(dF^*) + \partial R/\partial X(dX) \quad \ldots\ldots 9$$

$$dY = \partial R/\partial K_R(dK) + \partial R/\partial L_R(dL) + \partial F/\partial G_F(dG_F) + [1/(1+\delta)]\partial X/\partial F^*(dF^*) + \partial R/\partial F^*(dF^*) + \partial R/\partial X(dX) + \delta/(1+\delta)dX \quad \ldots\ldots 10$$

Assmption3: Following Feder (1983), I assume a linear relationship exists between the real marginal productivity of labour in a given sector and average output per labour in the economy. It was originally argued by Burno (1968).

$$\partial R/\partial L_R = B(Y/L) \quad \ldots\ldots 11$$

Let $\partial R/\partial K_R = \alpha$; $\partial F/\partial G = \mu$; $\partial R/\partial X = c$; where α, μ and c are constants representing marginal changes in the respective sectors with respect to a change in private capital, pubic capital and export output.

Dividing equation 6 by Y and replacing $\partial R/\partial L_R$ by B(Y/L), we get

$$dY/Y = \alpha(dK/Y) + \beta(dL/L) + \mu(dG_F/Y) + [1/(1+\delta)]\partial X/\partial F^*(dF^*/Y) + \partial R/\partial F^*(dF^*/Y) + \partial R/\partial X(dX/Y) + \delta/(1+\delta)dX/Y \quad \text{..... 12}$$

Assmption4: A plausible specification for the spill-over effects is to assume that public infrastructure affect export and non-export private sectors with a constant elasticity and, similarly, export affect the non-export private sector with a constant elasticity. The constant elasticity indicates the long-run partial effects of infrastructure output and export growth on the respective sectors. Wang (2002). So,

$$R = R(L_R, K_R; F^*, X) = (F^*)^Z \psi (L_R, K_R; X) \quad \text{..... 13}$$

$$R = R(L_R, K_R; F^*, X) = (X)^\omega \Psi(L_R, K_R; F^*) \quad \text{..... 14}$$

$$X = X(L_X, K_X; F^*) = (F^*)^V \phi (L_X, K_X) \quad \text{……..…….....…15}$$

Therefore,

$$\partial R/\partial F^* = z(R/F^*)$$

$$\partial X/\partial F^* = v(X/F^*)$$

$$\partial R/\partial X = \omega(R/X)$$

$$dY/Y = \alpha(dK/Y) + \beta(dL/L) + \mu(dG_F/Y) + [1/(1+\delta)]\, v(X/F^*)(dF^*/Y) + z(R/F^*)(dF^*/Y) + \omega(R/X)(dX/Y) + \delta/(1+\delta)dX/Y \quad \text{..... 16}$$

Rearranging terms,

$$dY/Y = \alpha(dK/Y) + \beta(dL/L) + \mu(dG_F/Y) + [v/(1+\delta)]\,(X/Y)(dF^*/F^*) + z(R/Y)(dF^*/F^*) + \omega(R/Y)(dX/X) + \delta/(1+\delta)(dX/X)(X/Y) \quad \text{..... 17}$$

After recursive expansion, the dynamic adjustment process of equation (6) is written as:

$$F^*_t = \theta\textstyle\sum(1-\theta)^s F_{t-s}\ ; \qquad 0 < s < \infty \quad \text{…….....…….…… 18}$$

“The expected level of F, which factors in the externality onto the private sector, is a weighted average of all present and previous values of Ft, since the weight sum to unity $[\theta\sum(1-\theta)^s = 1]$” Wang (2002).

Substituting equation (21) into equation (20) produces a specification associated with the adaptive expectation process. Equation (22) below is identical to the formulation of the Koyck geometric lag.

$$dY_t/Y_t = \alpha\theta(dK_t/Y_t) + \beta\theta(dL_t/L_t) + \mu\theta(dG_{Ft}/Y_t) + [v/(1+\delta)]\theta(X_t/Y_t)(dF_t^*/F_t^*) + z\theta(R_t/Y_t)(dF_t^*/F_t^*) + \omega\theta(R_t/Y_t)(dX_t/X_t) + [\delta/(1+\delta)]\theta(dX_t/X_t)(X_t/Y_t) + (1-\theta)dY_t/Y_{t-1} \quad \ldots\ldots 19$$

Equation (22) is a nested equation which encompasses the neo-classical one sector model if the first three terms are significant and the rest turns to be insignificant. The two-sector models with spill-over from the infrastructure sector and spill-over from the export sector. This is the equation which will be used for empirical study in the rest of the paper. The subscript ‘t’ represents time.

Appendex for Chapter 2

Annex 2.1: Variable definition and descriptions

Variable	Variable Name	Source	Description
Y	Real GDP	United nation National Account data base	Real GDP is obtained by adding up all outputs and subtracting intermediate inputs, and deflating by a GDP deflator.
Yag	Real Agricultural GDP	United nation National Account data base	It is added as the net real output of agriculture after adding up all outputs and subtracting intermediate inputs.
Ynag	Real Non-Agricultural GDP	own computation	Calculated as the difference between Real GDP and real agricultural GDP.
M1	Narrow Money	World development indicator	Money is the sum of currency outside banks and demand deposits other than those of central government.
M2	Broad Money	World Development Indicator	Broad money comprise the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government.
P	Consumer price index (2005=100)	World Development Indicator	Consumer price index reflects changes in the cost to the average consumer of acquiring a basket of goods and services.
REER	Real Effective Exchange Rate	IFS	Real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs.

Annex 2.2. Unit Root Test Results

	LLC		**Breitung**	**IPS**		**ADF**		**PP**	
eries	Constant	Constant &trend	Constant &trend	Constant	Constant &trend	Constant	Constant &trend	Constant	Constant &trend
Ln(M1/P)	2.365	-1.0544	1.504	4.362	0.38	6.635	16.158	3.931	14.719
	(0.991)	(0.146)	(0.934)	(1.000)	(0.648)	(0.993)	(0.582)	(0.999)	(0.681)
Ln(M2/P)	2.252	-0.443	1.954	4.838	0.126	6.403	25.226	3.864	21.327
	(0.998)	(0.329)	(0.975)	(1.000)	(0.550)	(0.994)	(0.119)	(0.999)	(0.2637)
LnY	4.869	0.073	4.528	8.473	1.79	0.269	16.11	0.247	18.405
	(1.000)	(0.529)	(1.000)	(1.000)	(0.963)	(1.000)	(0.585)	(1.000)	(0.429)
LnY^P	-0.195	0.115	0.936	2.717	1.488	9.412	14.14	0.305	24.999
	(0.423)	(0.545	(0.825)	(0.997)	(0.932)	(0.949)	(0.719)	(1.000)	(0.125)
r	0.129	0.973	0.936	-0.478	1.64	14.393	8.289	18.797	9.233
	(0.551)	(0.834)	(0.825)	(0.316)	(0.950)	(0.703)	(0.974)	(0.404)	(0.954)
Infl	-3.746	-6.586	-6.337	-3.933	-5.748	-45.856	68.527	79.31	84.348
	(0.000)***	(0.000)	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.001)***	(0.000)***	(0.000)***
LnREER	-1.861	-0.793	-1.487	-0.95	-1.242	23.54	21.689	24.665	35.837
	(0.031)**	(0.214)	(0.069)*	(0.171)	(0.107)	(0.171)	(0.246)	(0.134)	(0.007)***
ΔLn(M1/P)	-2.89	-1.225	-2.882	-4.921	-4.05	55.938	44.438	133.968	145.164
	(0.002)***	(0.110)	(0.002)***	(0.000)***	(0.000)***	(0.000)***	(0.001)***	(0.000)***	(0.000)***
ΔLn(M2/P)	-3.897	-2.65	-2.575	-5.133	-4.275	61.404	48.105	139.758	128.835
	(0.000)***	(0.004)***	(0.005)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
ΔLnY	-2.324	-0.576	-2.126	-4.637	-4.465	54.947	48.737	116.243	128.561
	(0.010)***	(0.282)	(0.017)**	(0.000)***	(0.000)***	(0.000)***	(0.000)	(0.000)***	(0.000)***
ΔLnY^P	-2.442	-5.720	-1.152	-4.245	-2.422	49.051	29.833	134.521	82.418
	(0.007)***	(0.000)***	(0.125)	(0.000)***	(0.008)***	(0.000)***	(0.39)**	(0.000)***	(0.000)***
Δr	-0.448	0.305	-1.352	-3.144	-2.231	36.224	28.548	150.153	134.889
	(0.327)	(0.620)	(0.088)*	(0.001)***	(0.011)**	(0.007)***	(0.054)*	(0.000)***	(0.000)***
ΔLnREER	-1.81	-0.811	-3.52	-6.288	-5.869	73.666	66.812	177.281	437.511
	(0.035)**	(0.209)	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
ΔInfl	-18.308	-15.100	-9.125	-17.838	-16.295	208.417	266.712	236.771	843.365
	(0.000)***	(0.000)	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.001)***	(0.000)***	(0.000)***

Annex 2-3:Permanent Income

Dependent Variable: LN_Y
Method: Panel EGLS (Cross-section weights)
Date: 05/30/16 Time: 16:37
Sample: 1980 2011
Periods included: 32
Cross-sections included: 8
Total panel (balanced) observations: 256
Linear estimation after one-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.177859	0.389926	3.020720	0.0028
LN_Y(-1)	1.089330	0.057911	18.81036	0.0000
LN_Y(-2)	-0.131411	0.085356	-1.539552	0.1248
LN_Y(-3)	0.027700	0.085051	0.325682	0.7449
LN_Y(-4)	-0.039231	0.084157	-0.466167	0.6415
LN_Y(-5)	2.77E-05	0.056692	0.000488	0.9996
TREND	0.003721	0.000723	5.145399	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.999739	Mean dependent var	37.0173
Adj. R-squared	0.999726	S.D. dependent var	21.4575
S.E. of regression	0.064807	Sum squared resid	1.14658
F-statistic	74690.64	Durbin-Watson stat	2.07754
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.999254	Mean dependent var	23.2700
Sum squared resid	1.232838	Durbin-Watson stat	2.39360

Appendex for Chapter 3

Annex 3.1: Empirical Simulation Model of the Modified Financial Programming

I. LONG-TERM GROWTH, INVESTMETN AND TOTAL FACTOR PRODUCTIVITY BLOCK

I.1 LONG-TERM OUTPUT GROWTH

QP = QP(-1) * (1 + POTN_GDP_GRWTH / 100)

QP_N - QP * DEF / 100 = 0

I.2 TOTAL INVESTMNET AND FACTOR PRODUCTIVITY GROWTH

1.2.1. TOTAL CAPITAL STOCK

K - (0.97 * K_INITIAL + 0.97 * K(-1) + I) = 0

K_GROSS - (K_INITIAL + K(-1) + I) = 0

I - (IP + IG) = 0

I_Q - (I / (QP)) * 100 = 0

K_DEPRCIATION - (K_GROSS - K) = 0

IG - QP * IG_Q = 0

IG_N - IG * DEF / 100 = 0

KG - (0.97 * KG_INITIAL + 0.97 * KG(-1) + IG) = 0

1.2.2. TOTAL PRIVATE SECTOR INVESTMENT REQUIRMENT

IP - (((D(D(LOG(QP))) - (-0.183503034257 * D(D(LOG(QP(-2)))) - 0.106004997805 * D(D(LOG(QP(-3)))) + 1.71976822694 * D(D(LOG(K))) + 0.19664274636 * D(D(LOG(N_TOT_P))) - 0.408390025544 * D(D(LOG(N_TOT_P(-1)))) - 0.569539825821 * D(D(LOG(N_TOT_P(-2)))) - 0.439300765271 * D(D(LOG(N_TOT_P(-3)))) + 0.0564811283951 * D(D(LOG(H))) - 0.140776312607 * D(D(LOG(F(-2)))) - 0.263242768798 * D(D(LOG(F(-3)))) + 0.0680585832204 * D(D(LOG(X))) - 0.069399063238 * D(D(LOG(X(-1)))) + 0.0493760491661 * D(D(LOG(X(-3)))) - 0.717469102927 * D(LOG(QP(-1))) - 0.0268409746155 *

D(LOG(N_TOT_P(-1))) + 0.107418803642 * D(LOG(H(-1))) + 0.0880306418235 * D(LOG(F(-1))) + 0.0122498854599 * D(DSB2007) * LOG(F(-1)) + 0.0577274789301 * D(LOG(X(-1))) - 0.0372668660874 * D(DUMY92))) * K(-1)) / 0.382067783136 - IG + K_DEPRCIATION) = 0

IP_Q = (IP / (Q - Q_STDSP)) * 100

1.2.3. TOTAL FACTOR PRODUCTIVITY GROWTH

1.2.3.1 HUMAN CAPITAL DEVELOPMENT

D(LOG(H)) - (0.129423990731 * D(LOG(H(-2))) + 0.375735200356 * D(LOG(H(-3))) + 0.157185306408 * D(LOG(H(-4))) + 0.260539125087 * D(LOG(H(-5))) + 0.166387199692 * D(LOG(PC_Y)) - 0.139086398482 * D(LOG(PC_Y(-1))) - 0.362345360557 * D(LOG(PC_Y(-5))) + 2.68906213055 * D(LOG(KG)) + 1.21509046962 * D(LOG(KG(-2))) + 0.863799456896 * D(LOG(KG(-5))) - 0.878846804927 * LOG(H(-1)) + 0.223316337166 * LOG(PC_Y(-1)) + 0.985537101845 * LOG(KG(-1)) - 8.03944544288) = 0

PC_Y - QP / N_TOT_P = 0

1.2.3.2 INFRASTRUCTURE OUTPUT

D(LOG(F)) – (0.462674592613*D(LOG(F(-1))) + 0.359919939011*D(LOG(F(-2))) + 0.196016413648*D(LOG(F(-3))) + 0.168014485558*D(LOG(F(-4))) + 1.69804357258*D(LOG(KG)) - 1.08464598977*D(LOG(KG(-1))) - 0.504782206813*D(LOG(KG(-4))) + 0.368251582682*D(LOG(N_URB_P)) - 0.856150520472*LOG(F(-1)) + 0.686835036126*LOG(KG(-1)) + 0.0228044756655*DSB2000*LOG(KG(-1)) + 0.0757609892028*LOG(N_URB_P(-1)) - 1.71077484516) = 0

1.2.3.3 EXPORTS OF GOODS AND SERVICES

D(LOG(X)) - (0.268353859968 * D(LOG(X(-1))) + 0.300174606784 * D(LOG(X(-2))) + 0.418604548907 * D(LOG(X(-3))) + 0.295587458819 * D(LOG(X(-4))) - 0.480365063468 * D(LOG(REER_F)) + 0.306014976245 * D(LOG(REER_F(-2))) + 0.616052380805 * D(LOG(REER_F(-3))) + 0.316361980242 * D(LOG(REER_F(-4))) + 1.09971230364 * D(LOG(Q_F)) - 1.31149447799 * D(LOG(Q_F(-1))) - 0.45502812056 * D(LOG(Q_F(-4))) - 0.783446772163 * LOG(X(-1)) - 0.52461230977 * LOG(REER_F(-1)) + 0.944273252806 * LOG(Q_F(-1)) + 0.415745132862 * DUMMY_84 - 0.439505310902 * DUMY92 - 1.16653174675) = 0

X_Q - X / Q * 100 = 0
X_USD - (X * DEF / 100) / E = 0
==========

II. SHORT-TERM AGGREGATE DEMAND BLOCK

Q - CP - CG - IP - IG - X + Z - Q_STDSP = 0

Q_PC - (Q / Q(-1) - 1) * 100 = 0

Q_N - Q * DEF / 100 = 0

2.1 PRIVATE CONSUMPTION EQUATION

D(LOG(CP)) – (-0.179586648238*D(LOG(CP(-1))) + 0.122746221169*D(LOG(CP(-4))) + 0.603184652123*D(LOG(YDI)) + 0.00109498323304*D(RINTRATE(-1)) + 0.000448527629734*D(RINTRATE(-2)) - 0.782175239731*LOG(CP(-1)) + 0.845005344123*LOG(YDI(-1)) - 0.00169299122456*RINTRATE(-1) - 0.971513880545) = 0

RINTRATE - (((1 + INTRATE) / (1 + DPD)) - 1) * 100 = 0

YDI - (QP_N - TX_Y + (FYNETW_USD + PVTRANSW_USD + OFFTRANSW_USD) * E) / DEF * 100 = 0

TX_Y - (TX_Y_R * Q_N) = 0

CP_Q - CP / (Q - Q_STDSP) * 100 = 0

2.2 GOVERNMENT CONSUMPTION

CG - CG_Q * QP = 0

2.3 IMPORTS OF GOODS AND SERVICES

Z - Q * Z_Q / 100 = 0

Z_USD - (Z * DEF / 100) / E = 0

==========

III. THE MONEY MARKET BLOCK

3.1 MONEY SUPPLY IDENTITIES

3.1.1 BROAD MONEY SUPPLY

M2 - M * M0 = 0

M2_Q_N - M2 / (Q * DEF / 100) = 0

3.1.2 RESERVE MONEY

M0 - (BBNFA + BBNGOV + BBNPVT + BBOIN) = 0
M0_PC - (M0 - M0(-1)) / M0(-1) * 100 = 0

BBNGOV - (BBNGOV(-1) + DBBNGOV) = 0

BBNFA - (BBNFA_USD) * E = 0

3.1.3 OTHER COMPONENTS OF BROAD MONEY

CBNPVT - (M2 + OIN - NFA - (BBNGOV + BBNPVT + CBNGOV)) = 0

OIN = OIN_R * BBOIN

NFA = BBNFA + CBNFA_USD * E

CBNGOV = CBNGOV(-1) + GOVCBFCYG - GOVCALDIFF

3.1.4 MONEY MULTIPLIER

M - ((1+C_DD +S_DD +T_DD) /(RQR *(1 +S_DD +T_DD) + C_DD + E_DD)) = 0

3.2 MONEY DEMAND

3.2.1 MONEY DEMAND EQUATION

D(LOG(M2D_PD_A)) - (-0.147176113783 * D(LOG(M2D_PD_A(-2))) - 0.32578719075 * D(LOG(M2D_PD_A(-3))) - 0.507080365094 * D(LOG(Q(-1))) - 0.241161338742 * D(LOG(Q(-2))) - 0.339919421401 * D(LOG(Q(-3))) - 0.367627116621 * D(LOG(PC_RUROUT)) + 0.399520194687 * D(LOG(PC_RUROUT(-1))) - 0.538041800196 * D(LOG(REER)) - 0.0583036952488 * D(LOG(REER(-1))) - 0.449168487092 * D(LOG(REER(-3))) - 2.20703547584 * D(INTRATE) - 2.92965939503 * D(INTRATE(-3)) - 0.663323119294 * LOG(M2D_PD_A(-1)) + 0.723995177031 * LOG(Q(-1)) - 0.681843094146 * LOG(PC_RUROUT(-1)) + 0.196939201437 * DSB2006 * LOG(PC_RUROUT(-1)) - 0.298990595682 * LOG(REER(-1)) - 1.89611375351 * INTRATE(-1) + 0.692630174946) = 0

M2D - (M2D_PD_A * PD_A / 100) = 0

3.2.2 PERCAPITA RURAL OUTPUT

RUROUT - (QAG_R * Q) = 0

PC_RUROUT - (RUROUT / N_RUR_P) = 0

3.2.3 MONEY MARKET EQUILIBRIUM

EXCESS_MONSUPPLY - (M2 - M2D) / M2D = 0

==========

IV. EXTERNAL SECTOR BLOCK

4.1 EXTERNAL FINANCING GAP IDENTITIY

FX_GAP - (X_USD - Z_USD + FYNETW_USD + PVTRANSW_USD + OFFTRANSW_USD + F_BOR_NET_USD + F_BOR_OTH_NET_USD + SHT_CAP_USD + FDI_USD - DBT_RELF_USD + ER_OM_USD - DBBNFA_USD - DCBNFA_USD) = 0

CUACB_USD - (X_USD - Z_USD + FYNETW_USD + PVTRANSW_USD + OFFTRANSW_USD) = 0

CAB_USD - (F_BOR_NET_USD + F_BOR_OTH_NET_USD + SHT_CAP_USD + FDI_USD + ER_OM_USD) = 0

FX_GAP_FEA = FX_GAP / FEA

FEA - (X_USD + FYNETW_USD + PVTRANSW_USD + OFFTRANSW_USD + F_BOR_NET_USD + F_BOR_OTH_NET_USD + SHT_CAP_USD + FDI_USD - DBT_RELF_USD + ER_OM_USD) = 0

FX_GAP_TARGET - (FX_GAP - FX_GAP) = 0

4.2 GROSS INT'L RESERVES AND CENTRAL BANK NFA

RES_IN_M_OF_Z - BBGROSR_USD / Z_USD * 12 = 0

BBNFA_USD - (BBGROSR_USD - BBGROSL_USD) = 0

==========

V. GOVERNMENT BUDGET CONSTRAINT BLOCK

GOVTOTFINCYG_GAP_Q_N - (TX + NTX + GRANT + GOVEXTFCYG + DBBNGOV + GOVCBFCYG + GOVNNBNKFCYG + GOVRESFCYG - GOVCON_E - GOVCAP_E) / Q = 0

GOVTOTFINCYG_GAP_Q_ADJ = 0.5 * GOVTOTFINCYG_GAP_Q_N

GRANT - GRANT_R * (OFFTRANSW_USD * E) = 0

GOVCON_E - GOVCON_E_R * (CG * DEF / 100) = 0

GOVCAP_E - GOVCAP_E_R * (IG * DEF / 100) = 0

GOVEXTFCYG - GOVEXTFCYG_R * (F_BOR_NET_USD * E) = 0

GOVCBFCYG = GOVCBFCYG_R * (M2 - M2(-1))
GOVNNBNKFCYG - GOVNNBNKFCYG_R * (M2 - M2(-1)) = 0

TX - TX_R * (Q * DEF / 100) = 0

NTX - NTX_R * (Q * DEF / 100) = 0
==========
VI. SAVING INVESTMENT EQUILIBRIUM BLOCK

6.1 DOMESTIC SAVINGS

S - (X - Z + I) = 0

SAVING_GAP - (S - I) = 0

S_Q - S / Q * 100 = 0
6.2 NATIONAL SAVINGS

S_NTL - ((X_USD - Z_USD + FYNETW_USD + PVTRANSW_USD + OFFTRANSW_USD) * E / DEF * 100 + I) = 0

SAVING_GAP_TOTAL - (S_NTL - I) = 0

S_NTL_Q = S_NTL / Q * 100

6.3 FOREING SAVINGS

S_FORGN - (CAB_USD - DBBNFA_USD - DCBNFA_USD - DBT_RELF_USD) * E /DEF * 100 = 0

6.4 SAVING-INVESTMENT EQUILIBRIUM

S_I - (SAVING_GAP_TOTAL + S_FORGN) = 0

S_I_Q - (SAVING_GAP_TOTAL + S_FORGN) / Q * 100 = 0
==========
VII. SHORT-TERM AGGREGATE DEMAND AND SUPPLY EQUILIBRIUM AND PRICES BLOCK

7.1 SHORT-TERM INFLATION DETERMINATION

DPD - (AGG_EXCESS_DD+WORLDFOODINFL+INFLATION_EXPECTATION)= 0

AGG_EXCESS_DD - 0.35 * EXCESS_MONSUPPLY = 0

WORLDFOODINFL - 0.35 * (WPF - WPF(-1)) / WPF(-1) = 0
INFLATION_EXPECTATION - 0.30 * DPD_E = 0

DPD_E -(0.95*(PD-PD(-1)) /PD_A(-1)+ 0.05 * (PD_A(-1) - PD_A(-2)) /PD_A(-2)) = 0

INFLATION - DPD * 100 = 0

PD_A - PD_A(-1) * (1 + DPD) = 0

INFLATION_TARGET - (PD - PD(-1)) / PD(-1) * 100 = 0

7.1 GDP DEFLATOR

LOG(DEF) - (0.912957714168 * LOG(DEF(-1)) + 0.116084564995 * LOG(DEF(-3)) - 0.143816162685 * LOG(DEF(-4)) + 0.55357000866 * LOG(PD_A) - 0.41822548015 * LOG(PD_A(-1)) - 0.14392786117 * LOG(PD_A(-2)) + 0.0816927201312 * LOG(PD_A(-3)) - 0.037907800095 * LOG(PD_A(-4)) + 0.170419328359 * DUMMY_85 + 0.103110993736 * DUMY93 + 0.0815637159291 * DUMY98 - 0.0374047157023 * DUMMY_2010 + 0.00629527458391 * @TREND + 0.0967173899042) = 0

Annex 3.2: Definition of Variables used in the MFP Model and Sources of Data

(In Local Currency Unless Otherwise Specified)

I. Endogenous Variables		
Name of the Variable	Definition of the Variable	Source of Data
AGG_EXCESS_DD	Aggregate Excess Demand	Computed from MOFED's National Accounts Statistics
BBNFA	Net Foreign Assets of the NBE	NBE, Annual Reports
BBNFA_USD	Net Foreign Assets of the NBE (in USD)	"
BBNGOV	Net Claims on Government by the National Bank of Ethiopia	"
CAB_USD	Capital Account of the BOPs (in USD)	"
CBNGOV	Net Government Borrowing from Commercial Banks (Calendar Month)	"
CBNPVT	Net Private Sector Borrowing from Commercial Banks	"
CG	Real Government Consumption Demand	MOFED, National Accounts
CP	Real Private Sector Consumption Demand	"
CP_Q	Private Consumption-to-GDP Ratio	MOFED National Accounts
CUACB_USD	Current Account of the Balance of Payments (in USD)	National Bank of Ethiopia, Annual Reports
DEF	GDP Deflator (2011 = 100)	MOFED, National Accounts Statistics
DPD	Change in Domestic Consumer Price as a Ratio of Previous Year's Price	National Bank of Ethiopia, Annual Reports
DPD_E	Change in Expected Consumer Price as a Ratio of Previous Year's Price	"
EXCESS_MONSUPPLY	Excess Money Supply	Computed from NBE, Annual Reports
F	Real Infrastructure Output	MOFED, National Accounts
FEA	Foreign Exchange Availability (in USD)	Computed from NBE's Annual Reports
FX_GAP	Foreign Exchange Gap (in USD)	"
FX_GAP_FEA	Foreign Exchange Gap as a Ratio of Foreign Exchange Availability (in USD)	"
FX_GAP_TARGET	Foreign Exchange Gap Target (in USD)	National Bank of Ethiopia, Financial Program
GOVCAP_E	Government Capital Expenditure	MOFED, Fiscal Statistics
GOVCBFCYG	Government Financing of the Budget from Commercial Banks (Fiscal Month)	"

Annex 3.2 (Cont'd): Definition of Variables used in the MFP Model and Sources of Data

(In Local Currency Unless Otherwise Specified)

I. Endogenous Variables (Cont'd)		
Name of the Variable	Definition of the Variable	Source of Data
GOVCON_E	Gov't Consumption Expenditure	"
GOVEXT FCYG	Government External Financing	"
GOVNNBN KFCYG	Government Non-Bank Financing	"
GOVTOTFIN CYG_GAP_Q_N	Government Total Financing Gap as a Ratio of Nominal GDP	Computed from MOFED, Annual Reports and Fiscal Statistics
GRANT	Grant Revenue in the Budget	MOFED, Fiscal Statistics
H	Human Capital Index	Computed from Central Statistics Authority's Publications
I	Real Gross Total Capital Formation	MOFED, National Accounts
I_Q	Real Gross Total Capital Formation as a Ratio of GDP	Computed from MOFED National Accounts Statistics
IG	Real Gross Government Capital Formation	MOFED, National Accounts Statistics
IG_N	Nominal Gross Government Capital Formation	Computed from MOFED National Accounts Statistics
INFLATION	Inflation Rate (Percentage Change in Consumer Price Index)	MOFED, National Accounts Statistics
INFLATION_ EXPECTATION	Inflation Expectation (Percentage Change)	Computed from NBE, Annual Reports
INFLATION_ TARGET	Inflation Target (Program Target)	Federal Democratic Republic of Ethiopia, 2010
IP	Real Gross Private Capital Formation	MOFED, National Accounts Statistics
IP_Q	Gross Private Capital Formation as a Ratio of GDP	"
K	Real Net Total Capital Stock	"
K_DEPRCIATION	Accumulated Depreciation of Capital Stock	"

Annex 3.2 (Cont'd): Definition of Variables used in the MFP Model and Sources of Data

(In Local Currency Unless Otherwise Specified)

I. Endogenous Variables (Cont'd)		
Name of the Variable	Definition of the Variable	Source of Data
K_GROSS	Real Gross Total Capital Stock	"
KG	Real Net Gov't Capital Stock	"
M	Broad Money Multiplier	NBE, Annual Reports
M0	High-powered (Reserve) Money	NBE, Annual Reports
M0_PC	High-Powered Money (Percentage Change)	"
M2	Broad Money Supply	"
M2_Q_N	Broad Money Supply as a Ratio of Nominal GDP	"
M2D	Broad Money Demand	"
M2D_PD_A	Real Demand	"
NEER	Nominal Effective Exchange Rate Index (2011 = 100)	Computed based on information from NBE, Annual Reports and IMF International Financial Statistics
NFA	Net Foreign Assets of the Banking System	National Bank of Ethiopia, Annual Reports
NTX	Non-Tax Revenue of the Government	MOFED, National Accounts Statistics
OIN	Other Item Net of the Banking System	National Bank of Ethiopia, Annual Reports
PC_ROUT	Per-capita Rural Output	MOFED, National Accounts
PC_Y	Per-capita GDP	"
PD_A	Consumer Price Index	Computed based on information from NBE and Central Statistics Authority
Q	Real GDP (Actual)	MOFED, National Accounts Statistics
Q_N	Nominal GDP (Actual)	"
Q_PC	Real GDP (Percentage Change)	"
QP	Real Potential Output	Federal Democratic Republic of Ethiopia, 2010

Annex 3.2 (Cont'd): Definition of Variables used in the MFP Model and Sources of Data

(In Local Currency Unless Otherwise Specified)

I. Endogenous Variables (Cont'd)		
Name of the Variable	Definition of the Variable	Source of Data
QP_N	Nominal Potential Output	Fed. Democratic Republic of Ethiopia, 2010
REER	Real Effective Exchange Index (2011=100)	Computed based on information from NBE, Annual Reports and IMF's IFS
RES_IN_M_OF_Z	Gross International Reserves in Months of next year's Imports of Goods and Services	NBE, Annual Reports
RGDP_GROWTH	Real GDP Growth	MOFED, National Accounts Statistics
RINTRATE	Real Interest Rate	NBE, Annual Reports
RUROUT	Rural Output	MOFED, National Accounts Statistics
S	Real Gross Domestic Savings (Domestic Private Sector plus Public Sector savings)	"
S_FORGN	Real Foreign Savings	NBE, Annual Reports
S_I	Saving-Investment Gap	Computed from MOFED's National Accounts
S_I_Q	Saving-Investment Gap as a Ratio of GDP	"
S_NTL	Real Gross National Savings	"
S_NTL_Q	Real Gross National Savings as a Ratio of GDP	"
S_Q	Gross Domestic Savings as a Ratio of GDP	"
TX	Total Tax Revenue	MOFED, Fiscal Statistics
TX_Y	Total Income Tax Revenue	"
WORLD FOODINFL	World Food Inflation	NBE's Annual Reports
WPF	Consumer Price Indices of Major Trading Partner Countries of Agricultural Outputs	"

Annex 3.2 (Cont'd): Definition of Variables used in the MFP Model and Sources of Data

(In Local Currency Unless Otherwise Specified)

I. Endogenous Variables (Cont'd)		
Name of the Variable	Definition of the Variable	Source of Data
X	Real Exports of Goods and Services	MOFED, National Accounts
X_Q	Exports of Goods and Services as a Ratio of GDP	Computed from MOFED National Accounts Statistics
X_USD	Exports of Goods and Services (in USD)	NBE, Annual Reports
YDI	National Disposable Income	MOFED, National Accounts
Z	Imports of Goods and Services	NBE, Annual Reports
II. Exogenous Variables (In Local Currency Unless Otherwise Specified)		
BBGROSL _USD	Gross International Liability of the NBE (in USD)	NBE, Annual Reports
BBGROSR _USD	Gross International Reserves of the NBE (in USD)	"
BBNPVT	Net Claims on the Private Sector of the NBE	"
BBOIN	Other Items Net of the NBE	"
CBNFA_USD	Net Foreign Assets of Commercial Banks (in USD)	"
CG_Q	Government Consumption to GDP Ratio	Computed based on information from MOFED National Accounts Statistics
DBBNFA_USD	Change in Net Foreign Assets of the NBE (in USD)	NBE, Annual Reports
DBBNGOV	Change in Net Claims on Government of the NBE	"
CBNFA_USD	Net Foreign Assets of Commercial Banks (in USD)	"
CG_Q	Government Consumption to GDP Ratio	Computed based on information from MOFED National Accounts Statistics
DBBNFA_USD	Change in Net Foreign Assets of the NBE (in USD)	NBE, Annual Reports
DBBNGOV	Change in Net Claims on Gov’t of the NBE	"

Annex 3.2 (Cont'd): Definition of Variables used in the MFP Model and Sources of Data

(In Local Currency Unless Otherwise Specified)

II. Exogenous Variables (Cont'd)		
Name of the Variable	Definition of the Variable	Source of Data
DBT_RELF_USD	Debt Relief (in USD)	NBE, Annual Reports
DCBNFA_USD	Change in Net Foreign Assets of Commercial Banks (in USD)	"
DSB2000	Dummy for Structural Change starting from 2000	
DSB2006	Dummy for Structural Change starting from 2006	
DSB2007	Dummy for Structural Change starting from 2007	
DUMMY_2007	Dummy for 2007	
DUMMY_2009	Dummy for 2009	
DUMMY_2010	Dummy for 2010	
DUMMY_2011	Dummy for 2011	
DUMMY_2012	Dummy for 2012	
DUMMY_2013	Dummy for 2013	
DUMMY_84	Dummy for 1984	
DUMMY_85	Dummy for 1985	
DUMY92	Dummy for 1992	
DUMY93	Dummy for 1993	
DUMY98	Dummy for 1998	
E	Nominal Exchange Rate of the Birr (Birr/USD)	NBE, Annual Reports
ER_OM_USD	Errors and Omissions of the Balance of Payments (in USD)	Computed based on information from NBE, Annual Reports
F_BOR_NET_USD	Official Net Foreign Borrowing From Abroad (in USD)	NBE, Annual Reports
FDI_USD	Foreign Direct Investment (in USD)	"
FYNETW_ USD	Net Foreign Income from Abroad (in USD)	"
GOVCAL DIFF	Difference between Fiscal and Calendar Month Gov't Borrowing from the Banking System	Computed from MOFED's Fiscal Statistics and NBE's Annual Reports

Annex 3.2 (Cont'd): Definition of Variables used in the MFP Model and Sources of Data

(In Local Currency Unless Otherwise Specified)

II. Exogenous Variables (Cont'd)		
Name of the Variable	Definition of the Variable	Source of Data
GOVCAP_ E_R	Gov't Capital Expenditure as a ratio of Gross Government Capital Formation	Computed from MOFED National Accounts and Fiscal Statistics
GOVCBF CYG_R	Commercial Bank Financing of Gov't Deficit as a Ratio of Change in Broad Money Supply	"
GOVCON _E_R	Gov't Consumption Expenditure to Gov't Consumption Demand Ratio	"
GOVEXTF CYG_R	Government External Financing to Official Net Foreign Borrowing Ratio	MOFED's Fiscal Statistics and NBE's Annual Reports
GOVNNBN KFCYG_R	Government Non-Bank Financing to Change in Broad Money Supply Ratio	"
GOVRESF CYG	Government Residual Financing	MOFED, Fiscal Statistics
GRANT_R	Grants to Official transfer Ratio	Computed from MOFED's Fiscal
IG_Q	Gross Gov't Capital Formation to GDP Ratio	Computed from MOFED's National Accounts
INTRATE	Minimum Interest Rate	NBE, Annual Reports
K_INITIAL	Initial Gross Total Capital Stock	Computed from MOFED's National Accounts
KG_INITIAL	Initial Gross Gov't Capital Stock	"
N_RUR_P	Total Rural Population of Ethiopia	Central Statistical Authority Reports
N_TOT_P	Total Population of Ethiopia	"
N_URB_P	Total Urban Population of Ethiopia	"
NTX_R	Non-Tax Revenue to GDP Ratio	MOFED, Fiscal Statistics
PD	Consumer Price Index (2011 = 100)	National Bank of Ethiopia, Annual Reports

Annex 3.2 (Cont'd): Definition of Variables used in the MFP Model and Sources of Data

(In Local Currency Unless Otherwise Specified)

II. Exogenous Variables (Cont'd)		
Name of the Variable	Definition of the Variable	Source of Data
POTN_GDP_ GRWTH	Potential Real GDP Growth Rate	Federal Democratic Republic of Ethiopia, 2010
PVTRANSW_USD	Private Transfers (in USD)	National Bank of Ethiopia, Annual Reports
Q_STDSP	Statistical Discrepancies in National Accounts	Computed based on information from MOFED National Accounts Statistics
QAG_R	Agricultural Output to GDP Ratio	Computed based on information from MOFED National Accounts Statistics
SHT_CAP_USD	Short-term Capital Net Inflows (in USD)	National Bank of Ethiopia, Annual Reports
TX_R	Total Tax Revenue to GDP Ratio	Computed based on information from MOFED National Accounts Statistics and Fiscal Statistics
TX_Y_R	Income Tax to GDP Ratio	"
Z_Q	Total Imports of Goods and Services to GDP Ratio	Computed based on information from NBE's Annual Reports

Annex 3.3: Real Effective Exchange Rate and Nominal Effective Exchange Rate

3.3.1 METHODOLOGY

$REER = \sum BREER_i$…….…. 1

$BREER_i = w_i\ (e^f_i/e)(PD^f_i/PD)$ ……..…….....…….. 2

where REER is real effective exchange rate, $\sum$ is the summation operator and $BREER_i$ is bilateral real effective exchange rate of country i. 'w' is a weight which measures the share of total trade (export plus import of goods) of a trading partner 'i' from total exports and imports of goods of Ethiopia. 'e' is nominal exchange rate of the Birr in terms of USD, i.e., USD-to-Birr ratio (Birr is the national currency); e^f is the exchange rate of a trading partner country in terms of USD, i.e., USD-to-trading-partner-country's-national-currency ratio; PD is domestic consumer price index; and PD^f is the consumer price index of a trading partner. The subscript 'i' refers to a major trading partner of Ethiopia. The top seventeen major trading partner countries, which accounts collectively for more than 80 percent of total trade are taken to construct the REER index.

3.3.2 Computation of REER and NEER Identities

3.3.2.1 Real Effective Exchange Rate (REER) Index

REER = BREERBEL + BREERCHI + BREERDJI + BREERFRA + BREERGER + BREERIND + BREERITA + BREERJPN + BREERKEN + BREERKOR + BREERNZD + BREERSA + BREERSWD + BREERSWZ + BREERTKY + BREERUK + BREERUS ……..…… 3

3.2.2.2 Bilateral Real Effective Exchange Rates of Major Trading Partner Countries (BREERs)

CUR_USD_INX_ ETH = (100 / 0.062034739) * CUR_BIRR_ETH

CUR_BIRR_ETH = 1 / E

Germany

CUR_BIRR_GER =CUR_USD_INX_GER * (CUR_USD_INX_ ETH / 100)

CUR_USD_INX_GER = (100 / 0.73417) * CUR_USD_GER

BREERGER =CUR_BIRR_GER * (CPI_ ETH / CPI_GER) * TRADE_WEIGHT_GER

China

CUR_BIRR_CHI =CUR_USD_INX_CHI * (CUR_USD_INX_ ETH / 100)

CUR_USD_INX_CHI = (100 / 6.46146) * CUR_USD_CHI

BREERCHI =CUR_BIRR_CHI * (CPI_ETH / CPI_CHI) * TRADE_WEIGHT_CHI

Saudi Arabia

CUR_BIRR_SA =CUR_USD_INX_SA * (CUR_USD_INX_ ETH / 100)

CUR_USD_INX_SA = (100 / 3.75000) * CUR_USD_SA

BREERSA =CUR_BIRR_SA * (CPI_ETH / CPI_SA) * TRADE_WEIGHT_SA

Switzerland

CUR_BIRR_SWZ =CUR_USD_INX_SWZ * (CUR_USD_INX_ ETH / 100)

CUR_USD_INX_SWZ = (100 / 0.947037) * CUR_USD_SWZ

BREERSWZ =CUR_BIRR_SWZ * (CPI_ ETH / CPI_SWZ) * TRADE_WEIGHT_SWZ

UnitedStates

BREERUS =CUR_USD_INX_ETH * (CPI_ ETH / CPI_US) * TRADE_WEIGHT_US

UnitedKingdom

CUR_BIRR_UK =CUR_USD_INX_UK * (CUR_USD_INX_ ETH / 100)

CUR_USD_INX_UK = (100 / 0.62857) * CUR_USD_UK

BREERUK =CUR_BIRR_UK * (CPI_ETH / CPI_UK) * TRADE_WEIGHT_UK

Japan

CUR_BIRR_JPN =CUR_USD_INX_JPN * (CUR_USD_INX_ ETH / 100)

CUR_USD_INX_JPN = (100 / 83.1045) * CUR_USD_JPN

BREERJPN =CUR_BIRR_JPN * (CPI_ ETH / CPI_JPN) * TRADE_WEIGHT_JPN

Belgium

CUR_BIRR_BEL =CUR_USD_INX_BEL * (CUR_USD_INX_ ETH / 100)

CUR_USD_INX_BEL = (100 / 0.73417) * CUR_USD_BEL

BREERBEL =CUR_BIRR_BEL * (CPI_ ETH / CPI_BEL) * TRADE_WEIGHT_BEL

Kenya

CUR_BIRR_KEN =CUR_USD_INX_KEN * (CUR_USD_INX_ ETH / 100)

CUR_USD_INX_KEN = (100 / 82.09824) * CUR_USD_KEN

BREERKEN =CUR_BIRR_KEN * (CPI_ ETH / CPI_KEN) * TRADE_WEIGHT_KEN

France

CUR_BIRR_FRA =CUR_USD_INX_FRA * (CUR_USD_INX_ ETH / 100)

CUR_USD_INX_FRA = (100 / 0.73417) * CUR_USD_FRA
BREERFRA =CUR_BIRR_FRA * (CPI_ETH / CPI_FRA) * TRADE_WEIGHT_FRA

Italy
CUR_BIRR_ITA =CUR_USD_INX_ITA * (CUR_USD_INX_ ETH / 100)
CUR_USD_INX_ITA = (100 / 0.73417) * CUR_USD_ITA
BREERITA =CUR_BIRR_ITA * (CPI_ ETH / CPI_ITA) * TRADE_WEIGHT_ITA

Netherlands
CUR_BIRR_NZD =CUR_USD_INX_NZD * (CUR_USD_INX_ ETH / 100)
CUR_USD_INX_NZD = (100 / 0.73417) * CUR_USD_NZD
BREERNZD =CUR_BIRR_NZD * (CPI_ ETH / CPI_NZD) * TRADE_WEIGHT_NZD

Sweden
CUR_BIRR_SWD =CUR_USD_INX_SWD * (CUR_USD_INX_ ETH / 100)
CUR_USD_INX_SWD = (100 / 6.69917) * CUR_USD_SWD
BREERSWD =CUR_BIRR_SWD * (CPI_ ETH / CPI_SWD) * TRADE_WEIGHT_SWD

India
CUR_BIRR_IND =CUR_USD_INX_IND * (CUR_USD_INX_ ETH / 100)
CUR_USD_INX_IND = (100 / 45.31603) * CUR_USD_IND
BREERIND =CUR_BIRR_IND * (CPI_ ETH / CPI_IND) * TRADE_WEIGHT_IND

South Korea
CUR_BIRR_KOR =CUR_USD_INX_KOR * (CUR_USD_INX_ ETH / 100)
CUR_USD_INX_KOR = (100 / 1129.31825) * CUR_USD_KOR
BREERKOR =CUR_BIRR_KOR * (CPI_ ETH / CPI_KOR) * TRADE_WEIGHT_KOR

Turkey
CUR_BIRR_TKY =CUR_USD_INX_TKY * (CUR_USD_INX_ ETH / 100)
CUR_USD_INX_TKY = (100 / 1.674955) * CUR_USD_TKY
BREERTKY =CUR_BIRR_TKY * (CPI_ ETH / CPI_TKY) * TRADE_WEIGHT_TKY

Djibouti
CUR_BIRR_DJI =CUR_USD_INX_DJI * (CUR_USD_INX_ ETH / 100)
CUR_USD_INX_DJI = (100 / 177.7) * CUR_USD_DJI
BREERDJI =CUR_BIRR_DJI * (CPI_ ETH / CPI_DJI) * TRADE_WEIGHT_DJI
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3.3.2.3 Nominal Effective Exchange Rate (NEER)

NEER = (TRADE_WEIGHT_BEL * CUR_BIRR_BEL) + (TRADE_WEIGHT_CHI * CUR_BIRR_CHI) + (TRADE_WEIGHT_DJI * CUR_BIRR_DJI) + (TRADE_WEIGHT_FRA * CUR_BIRR_FRA) + (TRADE_WEIGHT_GER * CUR_BIRR_GER) + (TRADE_WEIGHT_IND * CUR_BIRR_IND) +

(TRADE_WEIGHT_ITA * CUR_BIRR_ITA) + (TRADE_WEIGHT_JPN * CUR_BIRR_JPN) + (TRADE_WEIGHT_KEN * CUR_BIRR_KEN) + (TRADE_WEIGHT_KOR * CUR_BIRR_KOR) + (TRADE_WEIGHT_NZD * CUR_BIRR_NZD) + (TRADE_WEIGHT_SA * CUR_BIRR_SA) + (TRADE_WEIGHT_SWD * CUR_BIRR_SWD) + (TRADE_WEIGHT_SWZ * CUR_BIRR_SWZ) + (TRADE_WEIGHT_TKY * CUR_BIRR_TKY) + (TRADE_WEIGHT_UK * CUR_BIRR_UK) + (TRADE_WEIGHT_US * CUR_BIRR_ETH)

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3.3.2.4 Weighted Consumer Price Indices of Ethiopia's Major Trading Partner Countries (PF)

PF = (TRADE_WEIGHT_BEL * CPI_BEL) + (TRADE_WEIGHT_CHI * CPI_CHI) + (TRADE_WEIGHT_DJI * CPI_DJI) + (TRADE_WEIGHT_FRA * CPI_FRA) + (TRADE_WEIGHT_GER * CPI_GER) + (TRADE_WEIGHT_IND * CPI_IND) + (TRADE_WEIGHT_ITA * CPI_ITA) + (TRADE_WEIGHT_JPN * CPI_JPN) + (TRADE_WEIGHT_KEN * CPI_KEN) + (TRADE_WEIGHT_KOR * CPI_KOR) + (TRADE_WEIGHT_NZD * CPI_NZD) + (TRADE_WEIGHT_SA * CPI_SA) + (TRADE_WEIGHT_SWD * CPI_SWD) + (TRADE_WEIGHT_SWZ * CPI_SWZ) + (TRADE_WEIGHT_TKY * CPI_TKY) + (TRADE_WEIGHT_UK * CPI_UK) + (TRADE_WEIGHT_US * CPI_US)

3.3.2.5 Weighted Consumer Price Indices of Ethiopia's Major Agricultural Goods Trading Partner Countries (WPF)

WFP = (TRADE_WEIGHT_CHI * CPI_CHI) + (TRADE_WEIGHT_DJI * CPI_DJI) + (TRADE_WEIGHT_IND * CPI_IND) + (TRADE_WEIGHT_KEN * CPI_KEN) + (TRADE_WEIGHT_SA * CPI_SA) + (TRADE_WEIGHT_TKY * CPI_TKY)

Annex 3.4: Definition of Variables used in the REER and NEER Model

I. Endogenous Variables		
Name of the Variable	Definition of the Variable 1/	Source of Data
BREERBEL	Bilateral REER of Belgium vis-à-vis Ethiopia	NBE's Annual Reports and IMF, IFS
BREERCHI	Bilateral REER of China vis-à-vis Ethiopia	"
BREERDJI	Bilateral REER of Djibouti vis-à-vis Ethiopia	"
BREERFRA	Bilateral REER of France vis-à-vis Ethiopia	"
BREERGER	Bilateral REER of Germany vis-à-vis Ethiopia	"
BREERIND	Bilateral REER of India vis-à-vis Ethiopia	"
BREERITA	Bilateral REER of Italy vis-à-vis Ethiopia	"
BREERJPN	Bilateral REER of Japan vis-à-vis Ethiopia	"
BREERKEN	Bilateral REER of Kenya vis-à-vis Ethiopia	"
BREERKOR	Bilateral REER of South Korea vis-à-vis Ethiopia	"
BREERNZD	Bilateral REER of Netherlands vis-à-vis Ethiopia	"
BREERSA	Bilateral REER of Saudi Arabia vis-à-vis Ethiopia	"
BREERSWD	Bilateral REER of Sweden vis-à-vis Ethiopia	"
BREERSWZ	Bilateral REER of Switzerland vis-à-vis Ethiopia	"
BREERTKY	Bilateral REER of Turkey vis-à-vis Ethiopia	"
BREERUK	Bilateral REER of United Kingdom vis-à-vis Ethiopia	"
BREERUS	Bilateral REER of United States vis-à-vis Ethiopia	"
CUR_BIRR_BEL	Exchange Rate of Birr per Belgium's Currency	"
CUR_BIRR_CHI	Exchange Rate of Birr per Chinese Currency	"
CUR_BIRR_DJI	Exchange Rate of Birr per Djibouti's Currency	"
CUR_BIRR_ETH	Exchange Rate of Birr per USD	"
CUR_BIRR_FRA	Exchange Rate of Birr per France's Currency	"
CUR_BIRR_GER	Exchange Rate of Birr per Germany's Currency	"
CUR_BIRR_IND	Exchange Rate of Birr per Indian Currency	"
CUR_BIRR_ITA	Exchange Rate of Birr per Italy's Currency	"

1/ REER means Real Effective Exchange Rate

Annex 3.4 (Cont'd): Definition of Variables used in the REER Model and Sources of Data

I. Endogenous Variables (Cont'd)		
Name of the Variable	Definition of the Variable 1/	Source of Data
CUR_BIRR_JPN	Exchange Rate of Birr per Japanese Currency	IMF's IFS
CUR_BIRR_KEN	Exchange Rate of Birr per Kenyan Currency	"
CUR_USD_INX_BEL	Index of Exch. Rate of Birr per Belgium's Currency	"
CUR_USD_INX_CHI	Index of Exch. Rate of Birr per Chinese Currency	"
CUR_USD_INX_DJI	Index of Exch. Rate of Birr per Djibouti's Currency	"
CUR_USD_INX_ETH	Index of Exch. Rate of Birr per USD	"
CUR_USD_INX_FRA	Index of Exch. Rate of Birr per France's Currency	"
CUR_USD_INX_GER	Index of Exch. Rate of Birr per Germany's Currency	"
CUR_USD_INX_IND	Index of Exch. Rate of Birr per Indian Currency	"
CUR_USD_INX_ITA	Index of Exch. Rate of Birr per Italy's Currency	"
CUR_USD_INX_JPN	Index of Exch. Rate of Birr per Japanese Currency	"
CUR_USD_INX_KEN	Index of Exch. Rate of Birr per Kenyan Currency	"
CUR_USD_INX_KOR	Index of Exch. Rate of Birr per Korean Currency	"
CUR_USD_INX_NZD	Index of Exch. Rate of Birr per Netherland's Currency	"
CUR_USD_INX_SA	Index of Exch. Rate of Birr per Saudi's Currency	"
CUR_USD_INX_SWD	Index of Exch. Rate of Birr per Sweden's Currency	"
CUR_USD_INX_SWZ	Index of Exch. Rate of Birr per Switzerland's Currency	"
CUR_USD_INX_TKY	Index of Exch. Rate of Birr per Turkey's Currency	"
CUR_USD_INX_UK	Index of Exch. Rate of Birr per UK's Currency	"

1/ Index of exchange rate of Birr per trading partner's currency (2011 = 100)

Annex 3.4 (Cont'd): Definition of Variables used in the REER Model and Sources of Data

I. Exogenous Variables		
Name of the Variable	Definition of the Variable	Source of Data
CUR_BIRR_KOR	Exchange Rate of Birr per Korean Currency	Computed from IMF, IFS
CUR_BIRR_NZD	Exchange Rate of Birr per Netherlands' Currency	"
CUR_BIRR_SA	Exchange Rate of Birr per Saudi's Currency	"
CUR_BIRR_SWD	Exchange Rate of Birr per Sweden's Currency	"
CUR_BIRR_SWZ	Exchange Rate of Birr per Switzerland's Currency	"
CUR_BIRR_TKY	Exchange Rate of Birr per Turkey's Currency	"
CUR_BIRR_UK	Exchange Rate of Birr per UK's Currency	"
PF	Weighted General Price Indices of Ethiopia's Major Trading Partner Countries (2011 = 100)	"
CPI_FRA	Consumer Price Index of France (2011 = 100)	"
CPI_GER	Consumer Price Index of Germany (2011 =100)	"
CPI_IND	Consumer Price Index of India (2011 = 100)	"
CPI_ITA	Consumer Price Index of Italy (2011 = 100)	"
CPI_JPN	Consumer Price Index of Japan (2011 = 100)	"
CPI_KEN	Consumer Price Index of Kenya (2011 = 100)	"
CPI_KOR	Consumer Price Index of Korea (2011 = 100)	"
CPI_NZD	Consumer Price Index of Netherlands (2011 = 100)	"
CPI_SA	Consumer Price Index of Saudi Arabia (2011 = 100)	"
CPI_SWD	Consumer Price Index of Sweden (2011 = 100)	"
CPI_SWZ	Consumer Price Index of Switzerland (2011 = 100)	"
CPI_TKY	Consumer Price Index of Turkey (2011 = 100)	"
CPI_UK	Consumer Price Index of United Kingdom (2011 = 100)	"
CPI_US	Consumer Price Index of United States (2011 = 100)	"
CUR_USD_BEL	Exchange Rate of USD per Belgium's Currency	"
CUR_USD_CHI	Exchange Rate of USD per Chinese Currency	"
CUR_USD_DJI	Exchange Rate of USD per Djibouti's Currency	"
CUR_USD_FRA	Exchange Rate of USD per France's Currency	"
CUR_USD_GER	Exchange Rate of USD per Belgium's Currency	"
CUR_USD_IND	Exchange Rate of USD per Indian Currency	"

Annex 3.4 (Cont'd): Definition of Variables used in the REER Model and Sources of Data

I. Exogenous Variables (Cont'd)		
Name of the Variable	Definition of the Variable	Source of Data
CUR_USD_ITA	Exchange Rate of USD per Italy's Currency	"
CUR_USD_JPN	Exchange Rate of USD per Japanese Currency	"
CUR_USD_KEN	Exchange Rate of USD per Kenyan Currency	"
CUR_USD_KOR	Exchange Rate of USD per Korean Currency	"
CUR_USD_NZD	Exchange Rate of USD per Netherland's Currency	"
CUR_USD_SA	Exchange Rate of USD per Saudi's Currency	"
CUR_USD_SWD	Exchange Rate of USD per Sweden's Currency	"
CUR_USD_SWZ	Exchange Rate of USD per Switzerland's Currency	"
CUR_USD_UK	Exchange Rate of USD per United Kingdom's Currency	"
TRADE_WEIGHT_BEL	Belgium's Trade (Import plus Export) Weight	NBE's Annual Reports
TRADE_WEIGHT_CHI	China's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_DJI	Djibouti's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_FRA	France's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_GER	Germany’s Trade (Import plus Export) Weight	"
TRADE_WEIGHT_IND	India's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_ITA	Italy's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_JPN	Japan's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_KEN	Kenya's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_KOR	Korea's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_NZD	Netherland's Trade (Import plus Export) Weight	"

Annex 3.4 (Cont'd): Definition of Variables used in the REER Model and Sources of Data

I. Exogenous Variables (Cont'd)		
Name of the Variable	Definition of the Variable	Source of Data
TRADE_WEIGHT_SA	Saudi's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_SWD	Sweden's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_SWZ	Switzerland's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_TKY	Turkey's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_UK	United Kingdom's Trade (Import plus Export) Weight	"
TRADE_WEIGHT_US	United States' Trade (Import plus Export) Weight	"

Annex 3.5: Determining Long-term Growth Target Consistent Government Borrowing

In line with the FP principle and avoid the danger of flow of excess domestic credit, given gross international reserves target given by the targeted ratio of imports of goods and services coverage, the long-run equilibrium level of government borrowing from the central bank could be pre-determined outside the system in the money market. First, substituting equation (25) into equation (57), and equations (17) and (19) into the money supply equation (equation 16);then applying the money market equilibrium condition (equation 27); and rearranging the resulting equation, we get a money market equilibrium equation, which expresses net government borrowing from the central bank (ΔD_{mgt}) as a function of all the other variables as follows:

$M^d_t = (M^d/P_d)_{t-1}\,[1 + \Delta\ln(M^d/P_d)_t]P_{dt}$……...…….…….. 57

$$\Delta D_{mgt} = (M^d/P_d)_{t-1}[1+ (\sum\beta_{81}\Delta\ln(M^d/P_d)_{t-m-1} + \sum\beta_{82}\Delta\ln Q^T_{t-m} + \sum\beta_{83}\Delta\ln PC\text{-}RUROUT_{t-m} + \sum\beta_{84}\Delta r_{t-m} + \sum\beta_{85}\Delta\ln REER_{t-m} + \sum\beta_{86}\Delta\ln P_{dt-m-1} + \alpha_{81}[(\ln(M^d/P_d)_{t-1} + \alpha_{82}\ln Y^d_{t-1} + \alpha_{83}\ln PC\text{-}RUROUT_{t-1} + \alpha_{84}\Delta r_{t-1} + \alpha_{85}\ln REER_{t-1} + \alpha_{86}])]P_d/m - (F_{mt-1} + \Delta F_{mt}) - D_{mgt-1} + OIN_t \quad \ldots\ldots 58$$

For the long-term equilibrium solution, actual output (Q) is substituted by long-term output target (Q^T). Moreover, as interest rate and exchanger rate are exogenously determined policy instruments, actual real interest rate and real effective exchange rate are substituted by their respective targets. Using equation (26), we can compute the expected long-term level of per capita rural output (PC-RUROUT) by substituting long-term output target. Form money supply side, change in international reserves of the central bank (ΔF_{mt}) is a policy target in the FP framework. Finally, equation (58) could be solved for the equilibrium level of government borrowing consistent with long-term inflation and international reserves targets.

Annex 3.6: Asymptotic critical value bounds for the F-statistic

(Testing for the existence of a levels relationship)

Annex VII (i) Case I: No intercept and no trend

	0.100		0.050		0.025		0.010		Mean		Variance	
k	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0	3.00	3.00	4.20	4.20	5.47	5.47	7.17	7.17	1.16	1.16	2.32	2.32
1	2.44	3.28	3.15	4.11	3.88	4.92	4.81	6.02	1.08	1.54	1.08	1.73
2	2.17	3.19	2.72	3.83	3.22	4.50	3.88	5.30	1.05	1.69	0.70	1.27
3	2.01	3.10	2.45	3.63	2.87	4.16	3.42	4.84	1.04	1.77	0.52	0.99
4	1.90	3.01	2.26	3.48	2.62	3.90	3.07	4.44	1.03	1.81	0.41	0.80
5	1.81	2.93	2.14	3.34	2.44	3.71	2.82	4.21	1.02	1.84	0.34	0.67
6	1.75	2.87	2.04	3.24	2.32	3.59	2.66	4.05	1.02	1.86	0.29	0.58
7	1.70	2.83	1.97	3.18	2.22	3.49	2.54	3.91	1.02	1.88	0.26	0.51
8	1.66	2.79	1.91	3.11	2.15	3.40	2.45	3.79	1.02	1.89	0.23	0.46
9	1.63	2.75	1.86	3.05	2.08	3.33	2.34	3.68	1.02	1.90	0.20	0.41
10	1.60	2.72	1.82	2.99	2.02	3.27	2.26	3.60	1.02	1.91	0.19	0.37

Annex VII (ii) Case II: Restricted intercept and no trend

	0.100		0.050		0.025		0.010		Mean		Variance	
k	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0	3.80	3.80	4.60	4.60	5.39	5.39	6.44	6.44	2.03	2.03	1.77	1.77
1	3.02	3.51	3.62	4.16	4.18	4.79	4.94	5.58	1.69	2.02	1.01	1.25
2	2.63	3.35	3.10	3.87	3.55	4.38	4.13	5.00	1.52	2.02	0.69	0.96
3	2.37	3.20	2.79	3.67	3.15	4.08	3.65	4.66	1.41	2.02	0.52	0.78
4	2.20	3.09	2.56	3.49	2.88	3.87	3.29	4.37	1.34	2.01	0.42	0.65
5	2.08	3.00	2.39	3.38	2.70	3.73	3.06	4.15	1.29	2.00	0.35	0.56
6	1.99	2.94	2.27	3.28	2.55	3.61	2.88	3.99	1.26	2.00	0.30	0.49
7	1.92	2.89	2.17	3.21	2.43	3.51	2.73	3.90	1.23	2.01	0.26	0.44
8	1.85	2.85	2.11	3.15	2.33	3.42	2.62	3.77	1.21	2.01	0.23	0.40
9	1.80	2.80	2.04	3.08	2.24	3.35	2.50	3.68	1.19	2.01	0.21	0.36
10	1.76	2.77	1.98	3.04	2.18	3.28	2.41	3.61	1.17	2.00	0.19	0.33

Annex VII (iii) Case III: Unrestricted intercept and no trend

	0.100		0.050		0.025		0.010		Mean		Variance	
k	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0	6.58	6.58	8.21	8.21	9.80	9.80	11.79	11.79	3.05	3.05	7.07	7.07
1	4.04	4.78	4.94	5.73	5.77	6.68	6.84	7.84	2.03	2.52	2.28	2.89
2	3.17	4.14	3.79	4.85	4.41	5.52	5.15	6.36	1.69	2.35	1.23	1.77
3	2.72	3.77	3.23	4.35	3.69	4.89	4.29	5.61	1.51	2.26	0.82	1.27
4	2.45	3.52	2.86	4.01	3.25	4.49	3.74	5.06	1.41	2.21	0.60	0.98
5	2.26	3.35	2.62	3.79	2.96	4.18	3.41	4.68	1.34	2.17	0.48	0.79
6	2.12	3.23	2.45	3.61	2.75	3.99	3.15	4.43	1.29	2.14	0.39	0.66
7	2.03	3.13	2.32	3.50	2.60	3.84	2.96	4.26	1.26	2.13	0.33	0.58
8	1.95	3.06	2.22	3.39	2.48	3.70	2.79	4.10	1.23	2.12	0.29	0.51
9	1.88	2.99	2.14	3.30	2.37	3.60	2.65	3.97	1.21	2.10	0.25	0.45
10	1.83	2.94	2.06	3.24	2.28	3.50	2.54	3.86	1.19	2.09	0.23	0.41

Annex 3.6 (cont'd)

Annex VII (iv) Case IV: Unrestricted intercept and restricted trend

	0.100		0.050		0.025		0.010		Mean		Variance	
k	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0	5.37	5.37	6.29	6.29	7.14	7.14	8.26	8.26	3.17	3.17	2.68	2.68
1	4.05	4.49	4.68	5.15	5.30	5.83	6.10	6.73	2.45	2.77	1.41	1.65
2	3.38	4.02	3.88	4.61	4.37	5.16	4.99	5.85	2.09	2.57	0.92	1.20
3	2.97	3.74	3.38	4.23	3.80	4.68	4.30	5.23	1.87	2.45	0.67	0.93
4	2.68	3.53	3.05	3.97	3.40	4.36	3.81	4.92	1.72	2.37	0.51	0.76
5	2.49	3.38	2.81	3.76	3.11	4.13	3.50	4.63	1.62	2.31	0.42	0.64
6	2.33	3.25	2.63	3.62	2.90	3.94	3.27	4.39	1.54	2.27	0.35	0.55
7	2.22	3.17	2.50	3.50	2.76	3.81	3.07	4.23	1.48	2.24	0.31	0.49
8	2.13	3.09	2.38	3.41	2.62	3.70	2.93	4.06	1.44	2.22	0.27	0.44
9	2.05	3.02	2.30	3.33	2.52	3.60	2.79	3.93	1.40	2.20	0.24	0.40
10	1.98	2.97	2.21	3.25	2.42	3.52	2.68	3.84	1.36	2.18	0.22	0.36

Annex VII (v) Case V: Unrestricted intercept and unrestricted trend

	0.100		0.050		0.025		0.010		Mean		Variance	
k	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0	9.81	9.81	11.64	11.64	13.36	13.36	15.73	15.73	5.33	5.33	11.35	11.35
1	5.59	6.26	6.56	7.30	7.46	8.27	8.74	9.63	3.17	3.64	3.33	3.91
2	4.19	5.06	4.87	5.85	5.49	6.59	6.34	7.52	2.44	3.09	1.70	2.23
3	3.47	4.45	4.01	5.07	4.52	5.62	5.17	6.36	2.08	2.81	1.08	1.51
4	3.03	4.06	3.47	4.57	3.89	5.07	4.40	5.72	1.86	2.64	0.77	1.14
5	2.75	3.79	3.12	4.25	3.47	4.67	3.93	5.23	1.72	2.53	0.59	0.91
6	2.53	3.59	2.87	4.00	3.19	4.38	3.60	4.90	1.62	2.45	0.48	0.75
7	2.38	3.45	2.69	3.83	2.98	4.16	3.34	4.63	1.54	2.39	0.40	0.64
8	2.26	3.34	2.55	3.68	2.82	4.02	3.15	4.43	1.48	2.35	0.34	0.56
9	2.16	3.24	2.43	3.56	2.67	3.87	2.97	4.24	1.43	2.31	0.30	0.49
10	2.07	3.16	2.33	3.46	2.56	3.76	2.84	4.10	1.40	2.28	0.26	0.44

Source: Pesaran, et al (2001), "Bound Testing Approaches to the Analysis of Level Relationships" Journal of Applied Econometrics (16); pp. 289-326.

Note: The columns headed 'I(0)' refer to the lower critical values bound obtained when x_t is purely 1(0), while the columns headed 'I(1)' refer to the upper bound obtained when x_t is purely I(1).

Annex 3.7: Asymptotic critical value bounds of the *t*-statistic

Annex VIII (i): Case I: No intercept and no trend

	0.100		0.050		0.025		0.010		Mean		Variance	
k	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0	-1.62	-1.62	-1.95	-1.95	-2.24	-2.24	-2.58	-2.58	-0.42	-0.42	0.98	0.98
1	-1.62	-2.28	-1.95	-2.60	-2.24	-2.90	-2.58	-3.22	-0.42	-0.98	0.98	1.12
2	-1.62	-2.68	-1.95	-3.02	-2.24	-3.31	-2.58	-3.66	-0.42	-1.39	0.98	1.12
3	-1.62	-3.00	-1.95	-3.33	-2.24	-3.64	-2.58	-3.97	-0.42	-1.71	0.98	1.09
4	-1.62	-3.26	-1.95	-3.60	-2.24	-3.89	-2.58	-4.23	-0.42	-1.98	0.98	1.07
5	-1.62	-3.49	-1.95	-3.83	-2.24	-4.12	-2.58	-4.44	-0.42	-2.22	0.98	1.05
6	-1.62	-3.70	-1.95	-4.04	-2.24	-4.34	-2.58	-4.67	-0.42	-2.43	0.98	1.04
7	-1.62	-3.90	-1.95	-4.23	-2.24	-4.54	-2.58	-4.88	-0.42	-2.63	0.98	1.04
8	-1.62	-4.09	-1.95	-4.43	-2.24	-4.72	-2.58	-5.07	-0.42	-2.81	0.98	1.04
9	-1.62	-4.26	-1.95	-4.61	-2.24	-4.89	-2.58	-5.25	-0.42	-2.98	0.98	1.04
10	-1.62	-4.42	-1.95	-4.76	-2.24	-5.06	-2.58	-5.44	-0.42	3.15	0.98	1.03

Annex VIII (iii): Case III: Unrestricted intercept and no trend

	0.100		0.050		0.025		0.010		Mean		Variance	
k	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0	-2.57	-2.57	-2.86	-2.86	-3.13	-3.13	-3.43	-3.43	-1.53	-1.53	0.72	0.71
1	-2.57	-2.91	-2.86	-3.22	-3.13	-3.50	-3.43	-3.82	-1.53	-1.80	0.72	0.81
2	-2.57	-3.21	-2.86	-3.53	-3.13	-3.80	-3.43	-4.10	-1.53	-2.04	0.72	0.86
3	-2.57	-3.46	-2.86	-3.78	-3.13	-4.05	-3.43	-4.37	-1.53	-2.26	0.72	0.89
4	-2.57	-3.66	-2.86	-3.99	-3.13	-4.26	-3.43	-4.60	-1.53	-2.47	0.72	0.91
5	-2.57	-3.86	-2.86	-4.19	-3.13	-4.46	-3.43	-4.79	-1.53	-2.65	0.72	0.92
6	-2.57	-4.04	-2.86	-4.38	-3.13	-4.66	-3.43	-4.99	-1.53	-2.83	0.72	0.93
7	-2.57	-4.23	-2.86	-4.57	-3.13	-4.85	-3.43	-5.19	-1.53	-3.00	0.72	0.94
8	-2.57	-4.40	-2.86	-4.72	-3.13	-5.02	-3.43	-5.37	-1.53	-3.16	0.72	0.96
9	-2.57	-4.56	-2.86	-4.88	-3.13	-5.18	-3.43	-5.54	-1.53	-3.31	0.72	0.96
10	-2.57	-4.69	-2.86	-5.03	-3.13	-5.34	-3.43	-5.68	-1.53	-3.46	0.72	0.96

Annex VIII (v): Case V: Unrestricted intercept and unrestricted trend

	0.100		0.050		0.025		0.010		Mean		Variance	
k	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0	-3.13	-3.13	-3.41	-3.41	-3.65	-3.66	-3.96	-3.97	-2.18	-2.18	0.57	0.57
1	-3.13	-3.40	-3.41	-3.69	-3.65	-3.96	-3.96	-4.26	-2.18	-2.37	0.57	0.67
2	-3.13	-3.63	-3.41	-3.95	-3.65	-4.20	-3.96	-4.53	-2.18	-2.55	0.57	0.74
3	-3.13	-3.84	-3.41	-4.16	-3.65	-4.42	-3.96	-4.73	-2.18	-2.72	0.57	0.79
4	-3.13	-4.04	-3.41	-4.36	-3.65	-4.62	-3.96	-4.96	-2.18	-2.89	0.57	0.82
5	-3.13	-4.21	-3.41	-4.52	-3.65	-4.79	-3.96	-5.13	-2.18	-3.04	0.57	0.85
6	-3.13	-4.37	-3.41	-4.69	-3.65	-4.96	-3.96	-5.31	-2.18	-3.20	0.57	0.87
7	-3.13	-4.53	-3.41	-4.85	-3.65	-5.14	-3.96	-5.49	-2.18	-3.34	0.57	0.88
8	-3.13	-4.68	-3.41	-5.01	-3.65	-5.30	-3.96	-5.65	-2.18	-3.49	0.57	0.90
9	-3.13	-4.82	-3.41	-5.15	-3.65	-5.44	-3.96	-5.79	-2.18	-3.62	0.57	0.91
10	-3.13	-4.96	-3.41	-5.29	-3.65	-5.59	-3.96	-5.94	-2.18	-3.75	0.57	0.92

Source: Pesaran, et al (2001), "Bound Testing Approaches to the Analysis of Level Relationships" Journal of Applied Econometrics (16); pp. 289-326.

Note: The columns headed 'I(0)" refer to the lower critical values bound obtained when x_t is purely 1(0), while the columns headed 'I(1)' refer to the upper bound obtained when x_t is purely I(1).

Annex 3-8. Simulation Results of Baseline Scenario (2014-2025)

		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	AVERAGE (2014-2025)
I	GOODS AND MONEY MARKETS													
		% GROWTH RATES												
1.1	QP	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
1.2	Q	12.0	14.9	11.2	6.1	14.7	14.9	11.2	11.8	15.0	10.8	10.2	12.6	12.1
1.3	QP_Q (1.1 -1.2)	-1.0	-3.9	-0.2	4.9	-3.7	-3.9	-0.2	-0.8	-4.0	0.2	0.8	-1.6	-1.1
1.4	H	4.9	8.4	10.3	7.8	11.3	13.8	14.1	15.4	14.8	15.6	15.3	14.4	12.2
1.5	F	6.7	3.2	3.2	5.0	6.1	7.4	8.6	9.2	9.0	8.6	8.2	7.9	6.9
1.4	EXCESS_ MONSUPPLY	0.04	0.13	0.07	-0.01	0.03	0.09	0.16	0.15	0.15	0.18	0.21	0.20	0.1
1.5	INFLATION	12.6	15.8	13.3	10.3	8.8	10.8	13.0	12.6	12.1	12.9	14.1	13.4	12.5
		AS PERCENTAGE OF GDP												
1.6	IP	24.2	31.1	31.7	26.5	27.9	33.6	33.0	32.5	37.1	37.9	35.9	37.8	32.4
1.7	IG	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
II	SAVING-INVESTMENT EQUILIBRIUM													
		AS PERCENTAGE OF GDP												
2.1	S_Q	19.1	22.8	20.8	17.2	18.2	20.5	19.1	18.8	20.4	19.5	17.8	18.4	19.4
2.2	S_NTL_Q	29.8	32.1	29.6	26.2	26.6	28.2	26.3	25.6	26.6	25.3	23.3	23.3	26.9
2.3	I_QP	37.4	44.3	44.9	39.7	41.1	46.8	46.2	45.7	50.3	51.1	49.1	51.0	45.6
2.4	S_I_GAP_Q	-7.2	-10.3	-13.2	-13.4	-13.2	-15.5	-16.7	-16.7	-18.4	-20.5	-21.0	-22.0	-15.7
2.5	S_FORGN_Q	5.7	5.6	6.3	7.5	7.2	6.8	6.6	6.3	5.7	5.4	5.0	4.5	6.1
2.6	S_I_Q	-8.4	-9.3	-10.4	-11.0	-14.2	-16.4	-18.7	-21.5	-23.5	-25.4	-27.5	-29.5	-18.0

Annex 3-8 (Cont'd): Simulation Results of Baseline Scenario (2014-2025)

		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	AVERAGE (2014-2025)
III	EXTERNAL SECTOR													
		% GROWTH RATES												
3.1	X	21.2	7.1	-3.6	9.3	29.1	7.4	10.0	22.2	12.7	3.4	15.9	14.8	12.5
3.2	Z	19.6	17.2	13.4	8.2	17.0	17.2	13.4	14.0	17.3	13.1	12.4	14.9	14.8
3.3	REER	5.1	9.7	8.0	7.5	-0.4	1.5	3.5	3.2	2.7	3.4	4.5	3.8	4.4
		AS PERCENTAGE OF GDP												
3.4	X_Q_USD	14.8	13.8	12.0	12.4	13.9	13.0	12.9	14.1	13.8	12.9	13.5	13.8	13.4
3.5	Z_Q_USD	32.8	33.4	34.1	34.8	35.5	36.2	36.9	37.6	38.4	39.2	39.9	40.7	36.6
3.6	CUACB_USD (BILL. OF USD)	-3.6	-6.3	-9.0	-9.6	-10.9	-14.8	-18.1	-20.5	-26.5	-33.6	-39.0	-47.5	-19.9
3.7	CUACB_USD_Q	-11.0	-17.8	-24.4	-26.1	-27.3	-34.2	-39.7	-42.6	-50.9	-61.7	-68.9	-79.0	-40.3
3.8	FX_GAP (BILL. OF USD)	-0.77	-2.84	-4.71	-4.22	-4.98	-8.33	-11	-12.8	-18.2	-24.8	-29.6	-37.7	-13.3
3.9	FX_GAP_Q	-1.7	-5.6	-9.1	-7.4	-7.7	-12.3	-15.1	-15.9	-21.2	-27.3	-30.5	-37.4	-15.9
IV	FISCAL SECTOR													
		AS PERCENTAGE OF GDP												
4.1	TX_Q	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
4.2	NTX_Q	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
4.3	GOVCON_E_Q	7.9	8.0	7.7	7.6	7.7	7.7	7.5	7.2	7.2	7.2	7.0	7.0	7.5
4.4	GOVCAP_E_Q	11.5	11.7	11.2	11.1	11.2	11.3	11.0	10.5	10.5	10.5	10.3	10.2	10.9
4.5	GOVNNBNK-FCYG_Q	0.5	0.6	0.2	0.3	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.5
4.6	GOVTOTFIN-CYG_ GAP_Q	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.0